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MUNICIPAL BOND SALES

That municipal bonds are the favorites for safe standing investments is demonstrated by the higher prices paid for them; prices which have reduced the net returns to the investor well down toward 3½ per cent. Buffalo recently sold 4½ per cent. bonds at a price netting the purchasing syndicate 3.8 per cent., and the ultimate consumer will net a still lower rate. The reasons to which these favorable prices were attributed by the *Weekly Bond Buyer* are the general prosperity, the Federal income tax and the Postal Savings system, which operate from different angles but all tend to lower the net rate of income expected from municipal bonds.

The market seems to have recovered entirely from the early effects of the war and the rates of interest offered on their face can again be reduced to those prevailing several years ago.

The first instalment of tables showing the prospects for municipal improvements, published elsewhere in this number, reflect the improvement in the situation. Of course, it is not possible at this time to make any accurate predictions regarding work for next year and a good many city engineers do not trust themselves to make even a guess. But the general tone of the reports is good and it will be specially noted that the prospects in most of the cities reporting them are materially better than the performances for 1916.

While 1916 was not quite a record-breaking year in public improvements it was evidently one in which a very large amount of work was done, and the indications are that 1917 will be so far ahead of it that it is likely to be a record-breaking year.

The growth of cities, particularly of manufacturing cities, new and old, has been phenomenal in the past three years, and municipal improvements have not been able to keep up. City after city that has been visited gives all too prominent evidence that it has grown beyond the clothes it has been wearing and must work hard to catch up. This means that in many municipalities the question of cost of doing work will be a secondary consideration and if the money is obtainable at low rates of interest it will be procured and spent rapidly and in large amounts.

Prior to November there was a real scarcity of municipal bonds and the demand was greater than the supply. One of the most prominent demonstrations that 1917 will be be a record-breaking year is the fact that in November many cities and counties voted large amounts of bonds for improvement purposes and many more cities and towns announced definite or tentative plans for large expenditures in 1917 so that the investors will find that the issues of bonds will come nearer to supplying their demands. Money is coming to this country so rapidly, however, that there seems to be no present prospect of the supply fully satisfying the demands.

The only source of delay will be the inability in some cases of the managers of the city's finances to develop as rapidly as their cities, and the consequent mis-management of their departments or failure to recognize the necessity and real economy of prompt and sufficient expenditures upon well designed systems of public improvements.

The engineers and contractors will be found to be better prepared for the larger work demanded than the city councils and controllers.

This condition is not unique for there are manufacturing establishments struggling with their problems of enlargement which show the same lack of capacity in their managers to cope with the whole situation.

MUNICIPAL ENGINEERING FOR 1917

We are not going to make any rash promises for 1917, but this is a good time to call attention to the improvements in "Municipal Engineering" which have been made during the past year and to say that the improvements will continue during 1917. It will not be enough to hold our own, greater improvement will be necessary and we have those improvements developing and appearing each month.

The series of articles on Street Paving, which began in September, will continue until all the standard forms of construction and materials used have been covered. The practical nature of these articles, which are gathered from those most closely identified with the modern uses of paving materials has brought out many compliments for them and all the features will be continued with such additional new features as have demonstrated their value.

MUNICIPAAL ENGINEERING is highly pleased with the expressions of appreciation of its improvements which have been coming in large numbers lately, and is putting in its best work to continue to deserve them and, if possible, to increase their number and quality. The street paving series is only one of the good things in progress and in store for early publication, just as fast as space and thoro preparation will permit.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

The Construction and Maintenance of Stone Block Pavements

By R. Keith Compton, Chairman Paving Commission, Baltimore, Md., the Editor and Others.

The maintenance of the stone block is largely taken care of in the original construction, when that is according to modern methods, so that both construction and maintenance are covered in this one article. What is given concerning maintenance refers mainly to taking care of the older pavements, not so well designed or constructed as those of the last five years or so have been.

The methods of construction described are those latest developed—since the revival of interest in the paving material longest in use.

Much of the material in this article is derived from the standard specifications adopted by the American Society of Municipal Improvements at its last convention and from papers before that society, to which we are also indebted for some of the accompanying illustrations.

The practice under the Paving Commission of Baltimore, Md., is outlined in the portion of the article written by R. Keith Compton, chairman and consulting engineer, who has constructed some of the most satisfactory of the modern granite block pavements.

E. W. Stern, chief engineer in charge of highways, Manhattan boro, New York City, makes an interesting contribution to the discussion of maintenance.

THE construction of the granite block pavement really begins with the manufacture of the blocks and a few words on this subject may serve to show what are the practical limitations in exactness of measurements of blocks and of variations from specified dimensions.

The hardest granites, those formerly specified for paving purposes, wear smooth and slippery and any irregularity in texture produces irregularity in wear. Hard and uniform sandstones, such as Medina and Colorado, were more satisfactory for pavements because, while they may wear more rapidly, they wear more uniformly and therefore the pavement actually lasts longer before relaying or reconstruction becomes necessary and is smoother at all times. Study of the softer granites has demonstrated that they have the same advantages as the sandstones in this regard and there is a tendency in modern specifications to use the softer grades, provided they are uniform in texture.

The softer granites have the additional advantage that they split more regularly and more easily and can be dressed at less cost, so that the blocks can have smoother surfaces and joints can be correspondingly narrower and more uniform. Coarse-grained granite, that with hard spots, or segregation of the minerals composing the stone, should not be used, as it will wear irregularly.

Manufacture of Granite Blocks.

Granite occurs in actual layers, which may or may not be horizontal, and the large blocks of stone from the quarry are in one dimension of the thickness of these layers or lifts.

The blocks are broken from the lifts by blasting or wedging them out, the drill holes being located on the lines of the rift and the grain of the stone, which are at right angles to each other and approximately at right angles to beds or lifts.

The large blocks, loosened from the lifts by this blasting or wedging, are split into smaller blocks, say 2 to 5 feet cube, by drilling holes along the lines of rift and grain and driving in plugs and feathers. These smaller blocks are carried to the block yards where they are split into paving blocks. The blocks are 19 or 20 inches or some multiple thereof, measured along the rift, so that with blocks specified 5 inches deep they can be split into an even number of blocks of 5 inches depth, within the allowable variations from 4¾ to 5¼ inches depth. In the other direction, along the grain, the block can be split into eight blocks 8 inches long. The large block, say 80 inches cube, is first quartered by splitting across the middle each way, then each quarter is quartered, and split until out of the small blocks thus produced can be split eight blocks each 8 inches long. Drilling of holes along the lines of cleavage is necessary down to the last operation of cutting the last quartering into its four component blocks. Marking with a hand chisel across the rift is all that is necessary in this operation. The long splits are made along the rift, the next splits along the grain, and only the last splits in the third direction.

When the blocks are reduced to paving-block size, roughnesses are knocked off the faces with a hammer. Usually the sides are the rift, the ends are the grain and the tops and bottoms are parallel to the lift. The splitting being more difficult on this plane, the tops and bottoms are rougher than the ends and sides.

Noting the drill holes, widths of feathers and plugs and irregularities in planes of fracture, the reason for the specification of ⅜-inch joints is clear. Quarries differ also as to ease of splitting on one plane or another or all three, so that uniform blocks are obtained more readily from some quarries than others.

The early specifications required closer joints on the ends of the blocks than on the sides, to prevent undue wear of the joints running in the same direction as the traffic. This is still desirable, but with well placed joint filler is not so necessary as formerly.

The improvements in construction due to the better shape and size of stone blocks now available and the reduction in cost because of smaller blocks, less work on stone, and increase in durability, especially as to continuous retention of the smoother surfaces now available, on account of better methods

of laying, are making stone block pavements more popular in districts where stone is available.

Handling the Blocks.

Blocks are handled from the quarry, when possible, by loading them into skips which are carried on cars or wagons to the docks, lifted up by derricks and dumped into the holds of the vessels. When they are handled from vessel to car or wagon and from wagon to street pile they should be handled with the same care as bricks and should not be thrown or dropped. The sharp edges and corners are subject to the same chipping as those of bricks and the weights of blocks are greater and corners are sharper. The ideal way of delivery on the street is by dump truck, as shown in one of the accompanying photographs.

DUMPING GRANITE BLOCKS IN THIS WAY SAVES CHIPPING.

The contractor must ship his blocks all from the same quarry, where they are made according to the same plan of operation, otherwise they may differ materially in width of joints, smoothness of surfaces, squareness of joints, thickness, and depth. He must work closer to specifications than formerly, and, while a variation in depth of blocks of a half inch and in width of 1 inch is allowable according to the standard specifications, the further requirement of a 1-inch depth of sand cushion makes a separation of the shallowest blocks from the deepest blocks advisable. But, still more important is the requirement that the joints shall not exceed ½ inch in width for the upper inch of their depth, which is practically a requirement that the blocks shall be selected for width so that those in a course shall be of the same width. If blocks are carelessly gathered together from different sources, or care is not taken in the quarry to classify blocks according to this requirement, the contractor may find it necessary to spend considerable money in doing this sorting on the street.

When cement grout filler is used the joints may be a little wider because the hard filler protects the edges. With soft filler, if the joints are too wide the horses' shoes will chip and wear the edges too rapidly and the stones round off and become slippery and the surface becomes rough like the old cobble or old-style granite block pavement.

Sand Cushion and Mortar Bed.

The old custom was to even up the inequalities in the subgrade, which was formerly all the foundation required, with a thick layer of sand, in which the block-layer buried the blocks for a large fraction of their depth. It has been hard to teach men to lay blocks on a thin sand cushion, such as the standard specification of 1 inch, but that requirement is now met successfully and if the blocks are very nearly of the same depth, varying not more than say ¼ inch in neighboring blocks, the surface can be made smooth and uniform and, after the blocks have been tamped or rolled into complete bearing, no later displacement of the paving stones need be expected unless occasionally by accident. The sand cushion cannot be made as uniform in thickness as for a brick pavement or rolled before laying the blocks, because of the greater variation in depth of blocks.

Methods of laying sand, sand-cement, and mortar cushions were described in the article in this series on the construction of brick pavements.

The mortar bed has been used by a few engineers for granite block pavements, particularly in Baltimore and in Manhattan. It was used in Brooklyn in one street having 4-inch blocks. The mortar bed adds about 16 cents to the price per square yard in that locality, which may not be justified by the increase in value of the pavement. Where traffic is heavy or blocks are shallow it is more fully justified.

Granite blocks are sometimes set in the green concrete when they are used along the rails of street-car tracks for toothing, etc.

Laying the Blocks.

That straight courses of equal width blocks and with narrow joints are practical in regular work is shown by one of the accompanying photographs, which is but one of many of the same sort accompanying the papers on modern granite pavement construction which were presented to the last convention of the American Society of Municipal Improvements.

The contractor is interested in securing narrow joints, since granite blocks are sold by the square yard as measured in place, and when the joints are narrow the blocks cost him no more but he saves materially on the amount of filler required for the joints. If he is careful to hold the block dealer to the letter of the specifications in the sorting of the blocks, he has only the trouble and possibly the slight additional time to take to insure that his block-layers do their work properly and lay the blocks with the narrowest possible joints and perfectly straight courses. Padding with wide joints to secure yardage of blocks laid is as much against the paving contractor's interest as it is against the pavement's own interest. The only people who benefit by it are the contractor who furnishes the blocks and the block-layer, in case they are paid by the square yard laid.

Ramming of blocks into place is required, all unsatisfactory blocks to be removed with tongs and all low blocks to be raised by taking them out and adding enough sand so that when replaced and rammed they will conform to the regular surface. Pinch bars are not to be used to force blocks into position. No free sand is allowed in the joints.

Fillers for Joints.

In introducing the discussion of fillers the following important points must be noted:

As to grout filling—

1. To sprinkle the blocks thoroly before the grout filler is placed in the joints.

2. To keep the surface wet either by wet sand spread over the entire pavement, after initial set has taken place, or by sprinkling for 4 or 5 days after joints are filled.

3. To absolutely keep all traffic off from the pavement for at least 7 to 10 days after joints are poured with grout.

4. If possible street railway cars should slow up and never set their brakes for a stop along the line of pavement as this has a tendency to break the bond of the joints.

Cement grout must be a true one-to-one mixture and grout must be kept thoroly agitated until it is poured into the joints.

STRAIGHT COURSES AND NARROW JOINTS ARE EASY TO OBTAIN.

Pea stone or gravel should be eliminated from the joints but in any case must never be allowed to fill the joints up higher than 3 inches below the top of the blocks, or pot holes will develop.

As to bituminous filling—

1. The blocks must be clean and free from dust.
2. All blocks must be thoroly rammed. Filler must be heated as hot as possible without burning, so that it will flow freely and fill joint completely.

The following on construction and maintenance of granite block pavements is by R. Keith Compton, chairman and consulting engineer, Paving Commission, Baltimore, Maryland.

Fillers for Joints.

Only two kinds of filler are satisfactory, namely cement and bituminous, the use of one or the other to be determined by the engineer, after taking into consideration all interests in connection with the improvement. Both fillers have their advantages and disadvantages. Cement filler is more desirable, but at the same time it has the disadvantage of being noisy, and when flushed up even with the top of the blocks the pavement, particularly if it is of very hard granite, becomes slippery. Bituminous filler has the advantage of being less slippery, and the further advantage of enabling the engineer to open the street to traffic at once, but it has the disadvantage of not protecting the edges and corners of the blocks, thus allowing them in a few years to become rounded.

The cement filler should be applied by the machine mixing method rather than by hand, thus doing away with the weakness, as far as possible, of human agency. It should be applied from the mixer to the blocks by means of an enclosed chute so as not to allow the filler to separate.

One of the enclosed photographs shows a machine grout mixer and distributer at work.

The squeegee coat of cement should always be applied, except possibly when the pavement is on a heavy grade, and in this case brooming out slightly the top of the joints is an advantage, as it gives draft animals a foothold.

Where a bituminous filler is used the work should be done preferably during the warmer seasons of the year, when the blocks and other materials are dry and not chilled. This of course is not always possible.

Fine, hot gravel or sand should be used in connection with bituminous filler. If gravel is used a small amount should be first poured into the joints, the block then rammed, then more filler, then more gravel, until the joint is completely filled, and if the desire is to render the pavement noiseless, excellent results can be obtained by allowing the last pouring of the bitumen to run completely over the tops of the blocks about one-eighth of an inch in thickness, this then to be followed with a layer of hot sand or gravel. This gives a most desirable and noiseless pavement, and if properly applied the bitumen should last on top without materially spalling off for a period of two or three years. It can be very cheaply renewed if necessary.

Before the filler is applied the blocks should be thoroly rammed or rolled to a good bed and true surface. The question of rolling rather than ramming the blocks has been considered, but it has never been a success, because the tendency of the roller is to tilt the blocks. Ramming gives better results if every block is well bedded by means of a heavy blow with a rammer, but, like all human agencies, the rammer is liable to miss a few blocks.

Excellent results have been obtained in some municipalities by mixing hot sand with the bituminous filler before being poured.

On standard block streets joints should not exceed ½ inch in width, and where it is possible to do so without materially running up the cost of the granite blocks pavement, the joints should not be over ⅜ inch in width.

Crown.

Technically speaking, the granite block pavement, on account of its non-slippery surface, can be given more crown than the pavement with a smoother surface, such as asphalt or brick, but this does not work out in practice, because with an asphalt street the higher crown is more desirable in order to shed the water more quickly.

As with all pavements, crowns should vary with the grade. A 40-foot street on a 3 per cent grade should have at least a 0.6-foot crown.

Contractor's Steps in Construction.

Assuming that the street is clear, the contractor should first set the new curbs or re-aline or resurface the old, as may be called for in his contract. His grading gang should then proceed to excavate the street to the sub-grade. He should be careful to keep all storm-water inlets along the line clear so that in case of a storm the flow can be diverted into the inlets without serious wash to his sub-grade. After the excavation is made to the sub-grade, all soft spots should be removed and replaced with good material and the sub-grade thoroly rolled with a heavy roller. Any seepage in the sub-grade along the line, such as springs, etc., should be taken care of by tiled drains and carried into the nearest storm-water manhole or inlet. Properly draining the sub-grade is one of the most important items of public work.

After the sub-grade of the street has been rolled and dressed up to a line the proper distance under the finished surface of the street and parallel therewith, concreting should commence. In the meantime the sand and crushed stone should be piled along the line on the sub-grade where convenient and also on the intersecting streets at most convenient points, and so located that it can be conveyed to the mixer by means of wheelbarrows. Wherever possible the concreting should be started at the low grade end and continued up grade. Cement should be stored along the line in sufficient quantities to keep the mixer in continual operation, and sufficient cover should be kept on hand to protect it in case of rain or damp weather, otherwise the contractor is liable to lose considerable of this material by it becoming hard from dampness or rain, or becoming lumpy. In the meantime the grading gang should be kept continually at work so that the concreting operation can also continue.

Before the grading on a street has been commenced, the granite blocks should be placed in convenient piles along

the curbs so as to avoid the practice of hauling over the concrete base with wagons or carts as far as possible. If placed in convenient piles along the curb most of the blocks can be tossed into the bed of the street and very few of them will have to be wheel-barrowed in.

When granite blocks are laid on a mortar bed it is economical to the contractor and very important for the welfare of the work that the blocks be rammed as soon after being laid in place by the pavers as possible, and that the grouting gang keep up as closely to the pavers as is convenient. Unless this is done the mortar bed will set so hard that it will be impossible to ram the blocks to a true bed and surface, and in case of rain it will avoid loss of money to the contractor in having to take up and relay the blocks.

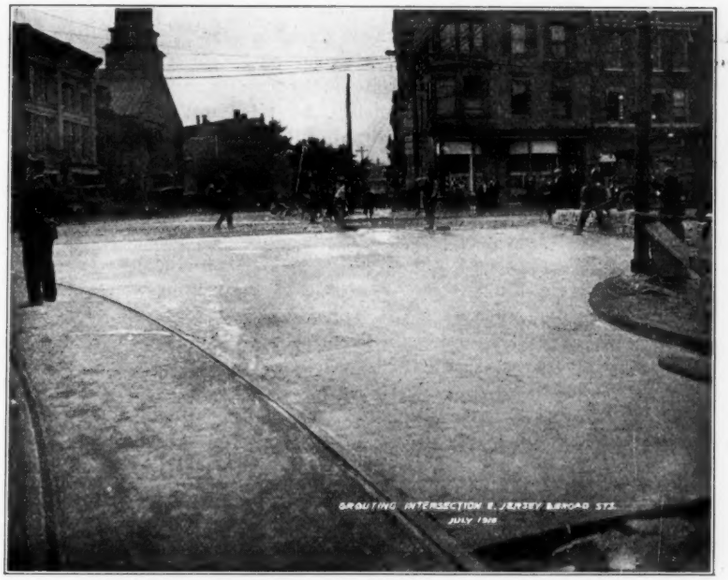
The writer believes that mixing the mortar bed and grout by machine is a labor saving method, and unquestionably better and more uniform grouting is obtained.

If bituminous filler is used the same methods of keeping up with the pavers should be pursued. In case of cement filler, the contractor should place sufficient barricades and watchman to keep traffic off of the work for a period of at least fourteen days. In case of bituminous filler, traffic can be allowed almost immediately on the work, just so long as it does not interfere with the contractors' operations.

During the progress of the several items of the work it is economical to the contractor to remove all debris and surplus material as his work progresses. This will avoid accidents, will make his work more shipshape, and will give the public the impression that the contractor handles his work in a businesslike manner. This may not be always possible, but in any event as soon as the paving is completed and teams can be allowed thereon, the contractor should immediately clean up the sidewalks and street intersections, clear gutters, etc.

Maintenance.

Under the heading of maintenance may properly be included the matter of cleaning. Flushing by means of a hose attached to a high-pressure fire plug is very undesirable, because this force will certainly disturb a bituminous filler from the top of the joints and very likely rupture a cement filled joint. The use of flushing machines with high pressure is equally undesirable from this standpoint. If the street paved with granite blocks is in a desirable business section, patrolmen with hand brooms and hand carts should be employed during the business hours keeping the street moderately clean. After business hours there should be brought into service the street sweeper, preceded by a light sprinkler.



SMOOTH SURFACE OF A NEWLY GROUTED STREET.

In the matter of repairs record data are very difficult to secure in this country, because improved granite blocks have only been laid within the past 15 or 20 years, and if designed and constructed in the proper manner should and do have a much longer life.

The maintenance enginer should divide his territory into districts, each district in charge of an assistant engineer or inspector, who should make frequent inspection. If any holes develop, no matter how small, they should be repaired at once, because if not repaired they soon grow larger, particularly with cement filler. If the original pavement was laid with cement, the repairs should be made with the same material, blocking the patches off from traffic by the most convenient method.

GROUT MIXER AND DISTRIBUTER FILLING JOINTS IN A GRANITE BLOCK STREET. BROOM-MEN AT THE LEFT INSURE THAT THE JOINTS ARE FILLED FLUSH.

A cement-filled block pavement is more difficult to repair than a bituminous-filled one. It is very bad practice in repairing a hole or a cut to square up the sides and ends, making a straight cut in the pavement. All edges should be toothed in and laid in the same manner as the original pavement, and the same methods pursued in restoring a worn place as are pursued in repairing a cut. With a bituminous-filled pavement this is a simple proposition, but with a cement-filled pavement is very difficult and requires special care.

The Highway Engineer's Department of Baltimore in repairing cuts in block pavements has given this matter special consideration, using a compressed air machine for the purpose. In a recent report Highway Engineer R. M. Cooksey states as follows:

"A great deal of difficulty has been experienced in making proper repairs to cuts in vitrified block and granite block streets where cement filler was

used. In order to obtain the best results in the past, stonecutters at the usual high rate of wages were employed for this work. In investigating with the view of outlining a more economical way of handling this work and securing as good if not better results in the workmanship, we tried out a compressed air machine operating chipping hammers for this purpose. This machine had been in use previously by the Water Department for calking pipe joints. After giving this a short trial we decided that it was an economical way in which to handle this work, and we therefore purchased a No. 2 portable compressed air outfit with hose and connections for hammers. Initial cost $345.50. In connection with this there were also purchased two No. 2 Thor chipping hammers at a cost of $70.00, making a total outlay of $415.50.

"After using this machine thru the entire season we find that the cost can be compared as follows:

"Average day's work for a stone cutter was 25 linear feet of toothing in vitrified brick work. The salary paid a stone cutter was $4.50 per day, which would make the cost to the city 18 cents per foot.

"Average day's work for the machine is 300 linear feet of toothing and the total cost of operating the machine, including depreciation, as outlined below, is $8.29, or at the rate of 2.76 cents per lineal foot, so that there was a saving of 15.24 cents per linear foot of trench repaired. As the city's repairs during the year will approximate 10,000 linear feet, you can readily see that the outfit will pay for itself in a very short while.

"The cost for operating the machine for one day on 300 feet of toothing is as follows:

5 gallons gasoline (present price)	$1.05
1 gallon cylinder oil	1.26
1 gallon Polarine oil	.23
1 special laborer	2.75
1 special laborer	2.50
Depreciation	1.50
	$8.29

"I would strongly recommend the use of this machine where there is any amount of trench work in either cement-filled granite block or vitrified block, as there is no doubt about its economical features."

As this machine has been so successfully operated by Mr. Cooksey in repairing cuts and trench work, it might be used with economy in making extensive repairs under the head of ordinary maintenance, that is to say for cleaning the cement out of the ends of the block so that they can be properly toothed in. Unquestionably it is a labor-saving device, accomplishes the purpose for which it was designed and overcomes the objection so often urged by engineers and contractors in making repairs to cement-filled pavements.

The following suggestions regarding maintenance of granite block pavements are made by E. W. Stern, chief engineer in charge of highways, Boro of Manhattan, New York City.

Old Granite Block Streets.

Old granite blocks with ¼ to ¾-inch joints that have had the joint filler washed out by flushing with hose, used in cleaning the streets, have been restored to fairly good surface by picking up an occasional depression and re-pouring the joints. We have done this during the past season over a large area which is under heavy traffic.

The joint filler used was asphaltic cement. During a short period the supply of asphalt was exhausted and tar filler was used. This portion of the work has been located and an inspection will be made next spring to ascertain whether the asphaltic cement or the tar filler has given the better result. The method of doing the work was as follows:

The gang, in charge of a foreman, consisted of one paver to do the small amount of paving necessary in adjusting the depressions to grade, and seven laborers. Joints were scraped out and broomed clean, then allowed to dry for a short time. Hot gravel ⅛ to ⅜ inch was then placed in joints until they were nearly filled; joint filler was then poured with a second or even a third pouring when necessary to fill the joints completely.

About 350 square yards was the usual average per day, all in heavy traffic streets. Experience shows that while the joints should be filled flush with the top of the blocks, there does not appear to be any advantage in covering the top of the blocks. Where this has been done the asphalt does not adhere to the top of the blocks but is soon worn off by the traffic.

Improved Granite Streets.

The streets paved with improved granite blocks with ⅜-inch joints are watched closely, and as soon as a slight depression is observed, it is repaired at once. The joint filler used on this class of work is 2/3 (in bulk) hot asphaltic cement with 1/3 hot sand, kept in suspension by frequent stirring. This mixture has given excellent results. Before relaying the blocks, a dry mortar bed ½ inch in thickness, one part portland cement to four parts sand, is spread over the concrete foundation. Immediately before the blocks are laid this mortar bed is slightly moistened with a sprinkling can.

One of our streets, 10th avenue, 40th to 51st street, paved with this class of granite, was badly damaged during the past spring and early summer by constant hauling of excessive loads on steel-tired platform trailers hauled by heavy motor tractors. Large areas in detached patches have been repaired and have withstood these heavy loads for about 5 months to date, without any noticeable damage. Constant personal supervision by the superintendent of maintenance or engineer is necessary to insure a proper care of pavements of all kinds.

A prompt repair of a small defect, especially in heavy traffic streets, is the true secret of maintenance.

H. H. Schmidt, chief engineer of the bureau of highways, Brooklyn Boro, finds it much easier to maintain a block laid with a bituminous filler. In cities it is particularly difficult to manipulate a cement-grouted pavement, especially rapidly growing cities where the great changes make frequent pavement openings necessary. Not only is the cement-grouted pavement more difficult to patch, but the necessity for blocking off the patches so the cement can set is a great impediment to traffic and in many cases is impractical.

THE AUSTIN, TEXAS, DAM

METHODS OF CONSTRUCTION AND OPERATION

By Frank S. Taylor, Austin, Texas.

This description of the design and construction of the Austin dam and the method of operating it is a continuation of an article by the author in MUNICIPAL ENGINEERING *for October, 1916, and shows the points of excellence in the design and some of the practical details of construction and operation.*

This new dam replaces structures which failed, and it withstands successfully the attacks made on it by the elements, tho it was injured somewhat by a record-breaking flood which came before the dam was very far along in construction, so that the injury was not serious and was readily repaired.

THE total length of dam and corewall is 1,535 feet, of which 1,091 feet are spillway, 124 feet bulkheads, and 300 feet corewall.

A typical section of the new portion of the dam is shown in figure 1. As indicated, it is a reinforced concrete structure, having an inclined upstream wall, making an angle of 42 degrees to the horizontal. At a point about 2½ feet above low water level, this slope of the wall ends, intersecting a narrow horizontal bench, and from the upstream edge of this horizontal bench a vertical wall goes straight down into the rock. This vertical wall forms both the lower portion of the deck and the cutoff wall, and in the designation used on the work is termed the "cutoff wall."

The object of the bench is to allow flow of water thru any completed section of the dam during construction, the flat horizontal slab, which runs the entire length of the dam, and covers the upper part of the bench, being omitted until the completion of the work. This top slab covers a space of 4 feet wide, measured horizontally from the upper edge of the cutoff wall to the lower edge of the inclined deck slab. Since the upper edge of the cutoff wall is only about 2 feet above mean low water, a rise of 2 feet will pass water over the cutoff wall thru the opening and thru the dam and a rise of 4 feet would give a thickness of water of 2 feet over the edge of the cutoff wall, which means that as much water would be passed thru and under the dam as would flow over the crest of an ordinary weir, the entire length of the dam, and 2 feet in depth over it. Normally, the total flow of the river was taken thru the sluice gates in the bottom of the dam, later to be described, but, in the case of floods, the openings thru the horizontal bench, together with the area afforded by the sluice gates, would usually take care of the whole river flow at such times, without an elevation in the water level of more than 4 to 6 feet.

The supporting walls are both longitudinal and transverse. The transverse walls are set parallel to the flow of the stream and are 20 feet apart, measured from centre to centre. The longitudinal walls are also spaced 20 feet apart, measured from centre to centre in a direction at right angles to them. These latter walls are not vertical but are inclined, so that they form an angle of nearly 90 degrees with the upstream deck. The slope of these walls is such that the resultant of the forces which they resist, made up of the water pressure acting against the surface of the deck and the gravity component of the deck and the walls themselves, has the same direction as that of the longitudinal walls. The longitudinal and transverse supporting walls intersect in a direction normal to the deck. The deck panels are exact squares, and hence may be reinforced in two directions. The reinforcing steel is, therefore, placed both longitudinally across the length of the dam and transversely up and down the deck. The spacing of the steel is logarithmic, the bars being laid closer and closer together as they get nearer and nearer the middle of the panel.

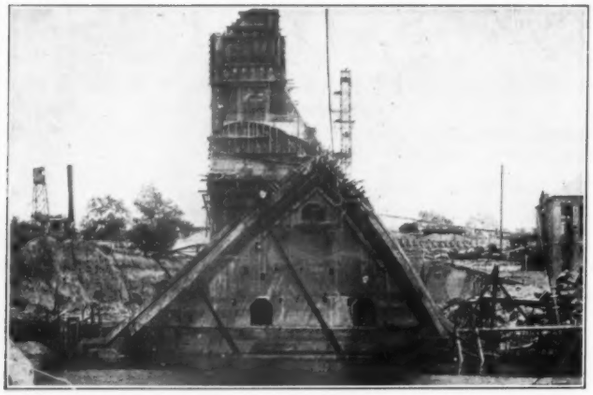
The stresses allowed in the steel are 16,500 pounds per square inch maximum.

All of the steel used was square-rolled twisted bars, of ingot steel, having an elastic limit above 55,000 pounds. The engineers considered the high elastic limit preferable to a high ultimate tensile strength, it being assumed that if stresses were imposed on the steel which would extend it past its elastic limit, the surrounding concrete would probably be crushed to such an extent that the structure would fail, and the only value that the steel could have lies in its resistance to distortion within its elastic limit.

Owing to the difficult character of the foundation, as has previously been stated, it was desirable to make the distance thru the bottom of the dam, measured from upstream to downstream side, as short as possible. In the usual form of design, the inclined deck goes up to the elevation of the crest of the dam, where it joins with the spillway. The form of the spillway is determined by the application of the ordinary parabolic formula, and this gives a certain distance, measured horizontally, from the crest of the spillway down to its toe. As shown in the typical section, figure 1, the spillway was designed in accordance with the usual method, and the sloping deck made to intersect it at some 25 feet further downstream and 6 feet lower vertically than in the customary design. By this method a proper length of theoretically designed spillway was made available, as well as an inclined deck of substantially the total height up to the spillway, and, at the same time, the length thru the dam from front to back was reduced about 25 feet, diminishing in a like proportion the length of the transverse walls, the length of each transverse wall foundation, and eliminating one longitudinal wall. While the saving in material and labor, due to this form of design, for a given factor of safety, was greatly reduced by the adoption of this design, the cost of the form work was increased so that the net saving effected, tho considerable, was not so great as would at first appear.

As shown in figure 2, the vertical transverse walls intersect the deck and the spillway, continuing on up above them in the form of piers, on the top of which are placed reinforced concrete girders that carry a railway track. Between these piers are placed the automatic crest gates, seen closed in the view.

The vertical buttress, or diaphram walls, have four large openings made in each, as indicated in the section. Thru the topmost series of these openings is placed a walkway, with iron railings on either side, so that it is possible to walk thru the new portion of the dam from end to end. Access is provided to the interior by means of spiral stairways, one placed at either end. These pass down thru a stair-well, each well



1. PHOTOGRAPH OF SECTION OF HOLLOW AUSTIN DAM DURING CONSTRUCTION, SHOWING THE SLOPING UP STREAM FACE, NARROW HORIZONTAL BRICK NEAR BOTTOM, THRU WHICH WATER FLOWED DURING THE CONSTRUCTION PERIOD; THE FACE OF ONE OF THE TRANSVERSE WALLS AND THE DOWNSTREAM FACE AND THE SPILLWAY WITH THE CONSTRUCTION FORMS STILL IN PLACE. THE POWERHOUSE IS ON THE RIGHT.

being formed in a pier, which is of sufficient width to accommodate it.

All the concrete used for making the deck and cut-off wall was rendered waterproof by an admixture of hydrated lime, in the proportion of 8 to 10 per cent (by weight) of the cement, the proportion being varied with variations in the voids in the aggregate. This has proved to be thoroly satisfactory, as were also the tests made of it prior to adopting this as standard construction on the work.

The concrete mixture was approximately 1-2-4, but no defiite proportion of ingredients was used at any time. The proportions were fixed always by making tests of the voids in the sand, stone and gravel. The proportions would be changed whenever the percentage of voids in these materials would show any change. Void tests were made every hour or oftener if indicated as mixing proceeded. The cement used was made by the Texas Portland Cement Company and tested for the requirements of the engineers by the Pittsburg Testing Laboratory. River sand and some river gravel were used for the other constituent parts. Most of the aggregate, however, was broken hard limestone.

Expansion Joints.

An ample number of expansion joints is provided in the new concrete dam, every fifth panel being an expansion panel. There are 28 panels in all. The first five panels, beginning on the east side, are monolithic, then comes an expansion panel, then five monolithic panels, and an expansion panel, and so on, until the west side is reached. These expansion panels have both the upstream deck and the spillway entirely separated from the adjacent portions of deck and spillway on either side of it. A joint is made betwen the two abutting edges of the concrete slabs, which is water tight, but which permits lateral movement of the different sections of the dam without diminishing the tightness of the joint or rupturing any of the masonry. This joint is made of Ingot iron plate, ½ by 8 inches. One-half the width of the strip, that is 4 inches, is cast into the concrete of the abutting edge of a standard panel. This leaves 4 inches of metal projecting out from the surface of the end of the panel. The end of the slab, together with the projecting iron, is painted over with a heavy coat of asphalt. The expansion panel is then cast so that its edge abuts against the edge of the slab of the standard panel. Due to the asphalt coating, the concrete cannot adhere to the metal of the expansion strip, nor to the adjacent concrete, while that portion of the iron strip cast into the standard panel and adjacent to the expansion panel, does firmly grip the metal. In this way, a watertight, sliding joint is formed. Since its construction, the dam has been subjected to temperatures varying from 32 to 90 degrees, and these expansion joints have proven thoroly satisfactory. Before construction was quite completed and when the whole of the dam was still exposed to the sun and atmospheric conditions, it was possible to see the space between the abutting ends of the panels at expansion joints change more than ¼ inch in a few hours.

Corewall.

Owing to the permeable condition of the limestone that forms the bluff on the east side of the river, a corewall joins the end of the bulkhead and passes eastward some 300 feet, forming, practically, a continuation of the dam into the rock. The depth of the corewall is somewhat lower than that of the foundation of the dam, varying from 75 to 90 feet. Without this impermeable, intercepting wall, there would be considerable leakage around the end of the dam, thru the limestone that forms the eastern bluff.

Piers.

The piers which are built on both the old and new sections are of the dimensions indicated in figure 2. Those on the crest of the low section, which are the taller and broader ones, are 22 inches in thickness, while those on the high section are 18 inches thick. The large piers are continuations of the diaphram walls which support the hollow dam section, and the reinforcing steel passes, continuously, from the foundation up to the top of these piers, so that they are amply strong to withstand the stresses produced by the pressure of the crest gates which they support.

The small piers were cast in place on top of the granite crest of the old dam, and, in order to reinforce them properly and to hold them in place, the vertical reinforcement bars were sunk into drill holes made into the granite and grouted into place, so that these piers likewise are firmly anchored into position.

Bridge.

As shown in figure 2 a bridge is built across the top of the dam, being supported on the piers. This bridge comprises two reinforced concrete beams, each 1 foot thick and 2 feet 6 inches deep, spaced 4 feet apart, center to center, and covered with a concrete slab 8 inches in thickness. On top of this slab are placed standard 6 by 8-inch cross ties, 8 feet long, and a standard-gage railway track is laid on these, the rails coming approximately over the beams. The ties are floored over and a pipe railing is put on the downstream side of the walkway thus formed. The railway track serves to carry a heavy, steel derrick car across the bridge, and a railing on the upstream side is omitted so that there is nothing to interfere with the operation of the tackle of the derrick car in case it is desired to move any portion of the gates for repairs, or lift out heavy trees coming down as driftwood, that might be too large to pass thru the openings.

Crest Gates.

The crest gates, which are placed between the piers that project upward beyond the crest of the dam, on both the high and low sections, are made up of a structural steel frame work, of which the lower portion is filled with concrete, while the upper part is covered with creosoted yellow pine. There are 28 large gates and 26 small ones, making a total of 1,091 feet of spillway. These gates turn about rockers or bascules, which are fastened into the piers at either end of the gate. The large gates, which are placed on the low section of the dam, have, in addition, a middle bascule to support the middle and take the heavy water pressure, due to the great size of

the individual gates. These large gates are, of course, continuous from pier to pier, and the middle bascule is placed on a low pier built entirely in the rear of the gate, the bascule projecting forward so that a portion of the rear surface of the gate rests against it. When the gates are vertical and the water is at normal height, the center of pressure coincides in elevation with the point of support on the bascule curve. When the water rises above the normal level, the center of pressure likewise rises, and there then exists a net moment to cause the gate to overturn. As overturning begins, the moment to cause it increases, due to the increase in pressure on the upper portion of the gate, and the diminution in pressure on the lower part. This increase in overturning moment is compensated for by the fact that the gate turning around the bascule is continuously changing its point of support, this point moving from a position at one-third the height of the gate to one very near the middle of the gate when it is, finally, in a horizontal position. In order to prevent the gates from leaving the bascules and being pushed downstream, guide pins are placed at either end of the gate, which pins operate in curved channels of cast iron, set into the concrete faces of the piers. Obviously, when the gates are turned to a horizontal position, the impounded water flows over the spillway crest, the gate being simply a vane in the current. In the case of the large gates, the water reaches an elevation of 65 feet, 9 inches, before overturning takes place. When the gates are in horizontal position, after overturning, the depth of water from the crest to the under side of the gate is 5 feet, 4 inches, while the depth of water from the upper surface to the surface of the water is 8 feet 5 inches, the thickness of the gate itself being one foot.

The small gates, which are 6 feet in height, overturn when the depth of water is 65 feet 4 inches, or when the water is 5 feet 4 inches in depth over the crest. These small gates, therefore, overturn before the large ones do, and, usually, the operation of the small gates gives more than ample discharge over the spillway to take care of normal river flow. Only in case of flood will the large gates open.

When the level of the water in the lake sinks sufficiently, these gates automatically close. This is effected by the counter-weighting provided by the concrete filling in the bottom of the gates, so that the center of gravity of the gates is near the bottom, and there is a continual tendency for gravity to restore them to their normal, vertical position. The small gates close when the water has sunk down to 63 feet 10 inches, or when the level of the lake has dropped some 14 inches below normal. The large gates close at a water elevation of 64 feet 8 inches, or when the level of the lake has fallen to 4 inches below its normal level.

These gates have not only operated in a thoroly satisfactory manner, but have passed one heavy flood, together with some fifty or sixty acres of driftwood that came down the river and accumulated in the lake prior to the full opening of the gates. In this latter respect, their performance is remarkable. When one of the large gates opens and 14 feet thickness of water begins to pass over the crest, the volume and velocity of discharge carry large trees thru the space between the piers, and over the upper surface of the gates, and when the spread of the branches of these trees is greater than the openings between the piers, the force of the water breaks up the limbs and carries the broken trees thru without difficulty.

The advantage of these gates under these particular conditions is obvious, and, by their use, the greater amount of the flood waters is discharged over the low section of the dam, preventing any considerable thickness of water over the crest of the higher section, and, in addition, the lake level undergoes no substantial change between the lowest and highest river stages, the minimum level being about 14 inches below the normal and the maximum level for heavy floods is not more than 34 inches above the normal level.

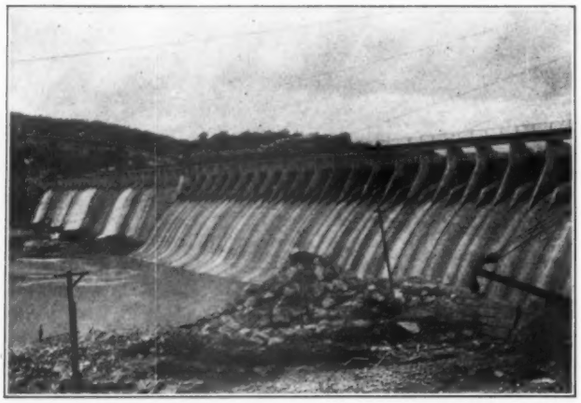
3. THE HOLLOW CONCRETE DAM AT AUSTIN, TEXAS, UNDER CONSTRUCTION. NOTE THE FORMS FOR CONSTRUCTING THE PIERS AND WALLS TO SUPPORT THE CREST GATES AND THE BRIDGE, ALSO THE COFFER DAM BEHIND WHICH THE SLUICE GATES WERE CONSTRUCTED.

Obviously, the construction of these gates is strong and massive, due to the great pressures that they have to withstand. The pressure against each of the large gates, with normal elevation of lake level is about 64 tons, while the pressure against each of the small gates is about 8 tons.

Sluice Gates.

There are eight sluice gates set in pairs, each discharging into its own opening; the two individual channels merging into one large tunnel, which passes thru the dam. The gates are each 5 by 6 feet and are operated by pistons working in cylinders, the working fluid being oil under a pressure of 750 pounds per square inch. The cylinders are 12¾ inches inside diameter and the pistons have a 78-inch stroke. The direction of the water is changed on entering the throat of the sluice-gate passageway thru a gradual curve until the direction of flow becomes horizontal, and also, the channels increase in area gradually so that practically no eddy currents are formed until after the two individual channels merge into the single large one, which passes thru the bottom of the dam. Since this single channel is 18 feet wide, and approximately 14 feet high, the total area is 250 square feet, while the area of the openings of the two sluice gates is only 30 square feet each, or 60 square feet for the two. The velocity of efflux thru the sluice gates will be about 60 feet per second, while the velocity thru the main channel will be less than 15 feet per second.

It is to be noted that the oil-pressure cylinders which operate the gates are placed on the outside of the deck of the dam instead of inside the dam, as is usually customary. In this way the cylinders could be placed much nearer to the sluice gates than is possible when the cylinder is inside the dam, and the sluice gates outside, with the thickness of the inset of the deck wall between the two. This, of course, shortens the piston rod, which, when the gate is being closed, acts as a long column, and for a given diameter of rod, it is stiffer, or for a given pressure, a smaller rod may be used. This means that the size of the cylinder may be somewhat reduced. Furthermore, the saving in concrete and form work, effected by mounting these cylinders on the outside instead of the inside, amounted to some $5,000. Not having any inset made in it, the dam is stronger at the bottom than it would be with one. It is true that this method of installation has the apparent objection that the cylinders cannot be inspected or repaired, as they are normally under 60 feet of water. This objection,



2. THE FINISHED AUSTIN DAM, SHOWING THE DOWN-STREAM FACE. THE LARGE CREST GATES ARE SEEN, CLOSED. THEIR SUPPORTING PIERS, WHICH ARE EXTENSIONS OF THE TRANSVERSE WALLS IN THE DAM ITSELF, SUPPORT THE CONCRETE BRIDGE ABOVE.

however, is a purely academic one. The amount of operation of these gates will never be sufficient, in many years, for the element of wear to have any bearing on the subject. An ordinary Corliss engine, in two hours, will make more strokes than these cylinders will in fifty years. Metallic packing is provided so that it is permanent and not subject to deterioration with time, as most organic substances would be. The pistons are of bronze, so that there is no question of them sticking or rusting to the interior of the cylinders, and this is further prevented by the fact that the cylinders are continuously filled with oil.

A Deane, triplex, pressure pump, having a capacity of 40 gallons per minute, under a pressure of 850 pounds per square inch, is installed in the power station and driven by a Western Electric, induction motor, which is belted to the pump. A pressure by-pass is provided so that the pump can work continuously when the gates are being operated and any excess pumpage will pass from the discharge to the suction pipe, the by-pass valve between the two openings when the predetermined pressure for which it is set, has been reached. The high-pressure service pipe, and the low-pressure pipe for return of oil to the suction side of the pump, run from the power house into the dam and pass along the side of the walkway thru the dam, these two pipes forming two of the three railings on one side of the walkway. At each of the branch pipe connections to the gate cylinders is placed a specially designed, high-pressure 4-way valve and the movement of a valve in one direction or the other admits the oil, under pressure, to one end or the other of the operating cylinder it controls, thereby causing opening or closing of the gate.

In order to determine the position of the gates, an indicator is provided on each one, which comprises a section of ⅜-inch copper wire cable attached to the gate, passing a short distance up the deck, then thru the deck into the inside of the dam. In the hole thru the deck is placed a piece of 1-inch pipe, which extends several feet into the inside of the dam, and it is thru this pipe that the copper wire cable passes. A stuffing box is provided at the inner end of the pipe, so that there is no leakage thru it, and on the inside end of the cable is hung a concrete weight of about 75 pounds. Where a change in the direction of the cable is made, it is properly guided on a pulley. Obviously, any motion of the gate produces a corresponding vertical motion of the weight at the end of the wire cable. Adjacent to the vertical path of this weight is placed a gage having the gate positions marked on it, corresponding to given vertical positions of the weight. In this way, a simple, positive and reliable gate indicator is produced.

The gates themselves are heavy slabs of cast iron, about 1½ inches thick, 5 feet 8 inches wide by 6 feet 8 inches long, the smaller dimension being the transverse one. Heavy ribs are cast at intervals on the outer surface of this gate, tapering from 4 inches high at the end to 7½ inches high at the middle, the thickness of the ribs being 1½ inches. The spacing of the ribs is 12 inches. Each gate slides on a heavy cast iron frame work which is sunk into the concrete. The upper side of the gate frame and the under face of the gate are both lined with bronze strips 2 inches wide by ⅜-inch thick. These gates have been operated a number of times under varying depths of water, and have proven themselves satisfactory in every particular. The sluice gates and frames were built by the Alamo Iron Works of San Antonio, Texas, while the cylinders with their pistons, and the operating, four-way pressure valves were made from special designs by the Tips Foundry & Machine Works of Austin, Texas.

Ornamental Street Lights in Los Angeles

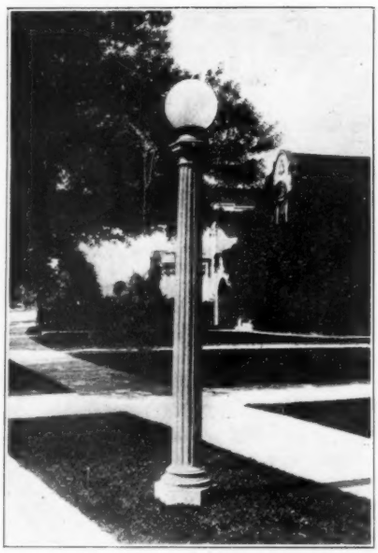
Single-lamp standards of the type illustrated herewith are having a great vogue in Los Angeles and other communities in the Southwest, and constitute striking evidence of the growth of the artistic spirit in street lighting.

The standards are of Marbelite made by The American Cement Products Company of America.

The light is enclosed in a Moonstone plain ball made by the Jefferson Glass Company of Follansbee, W. Va.

The balls were personally selected by President Landwehr, of the Cement Products Company, and will be used on an extensive installation of this type on Wilshire Boulevard in Los Angeles, said to be one of the most attractive streets in the world.

These standards and balls have proved to be a most efficient lighting unit, and this fact coupled with their artistic merit promises a wide spread popularity for this type of street illumination.



Traffic Census and Pavement Maintenance

A STUDY OF THEIR RELATIONS

By Harry F. Harris, Assoc. M. Am. Soc. C. E., Assistant Engineer of Streets, Trenton, N. J.

It was quite unusual a few years ago to find any definite figures in regard to the cost of maintaining the various types of pavements on individual streets, in the different American municipalities. Buffalo, New York, Washington, D. C., Syracuse, New York, and a few other cities were conspicuous exceptions. But during the last half dozen years the number of cities tabulating such data has increased considerably, due to the fact that the importance of keeping these figures has been repeatedly referred to editorially, in the municipal engineering publications. The value of data of this sort has also been pointed out in numerous technical papers, so that the city engineers quite generally thruout the country have been pretty thoroly convinced that figures of this character are very essential.

However, the point which the writer wishes to emphasize is this: the information relative to maintenance costs is excellent so far as it goes. But, are maintenance cost records of real value without traffic records? It seems that this very praiseworthy idea of keeping accurate maintenance costs should go a step further. We should know under what conditions of traffic the street is placed. For example, a sheet asphalt pavement ten years old laid with Bermudez Lake asphalt on a 6-inch gravel-concrete foundation has an average cost per square yard per year of $0.001 for maintenance in one case; while a street built in the same manner with the same materials, six years old, has an average cost per square yard per year for maintenance of $0.092. Or to illustrate further, if we had data showing maintenance cost with traffic recorded therewith, we could determine within very narrow limts which would be the most economical form of construction for a given degree of traffic.

Having the traffic record would be advantageous for other reasons. We would be able to compare the wearing qualities of our fire-clay vitrified block, for instance, with shale block laid under identical traffic conditions, or still further we could determine up to what point it would be advantageous for us to construct plain macadam, and then to cease this form of construction and lay bituminous carpeted macadam, etc.

The cost of maintenance for a certain degree or intensity of traffic should be known. This is one of the most essential factors affecting maintenance costs, and if we do not have these data in conjunction with our cost per yard per year, our figures convey very little real information to us. It would therefore seem that the time has come to urge the adoption of methods which would result in bringing out information of this sort. Both the American Society of Municipal Improvements and the American Society of Civil Engineers are doing meritorious work in endeavoring to have definite units established for traffic census work. It is very important that we have our units standardized, because by working with arbitrary units the value of the work is reduced, when the records of one city are compared with another using different units.

In the city in which the writer resides, the engineers for some years realized the importance of keeping data of this sort, but until the year 1911, the administration of the city was conducted under the councilmanic form with 28 members, and it was then almost impossible to get any innovations into practice in the engineering department. The value of a new system of this character was difficult to impress upon the average laymen, who made up the committees directing the work of the engineering department. But during the year 1911 the plan of government was changed to the commission form, and, fortunately, a civil engineer of considerable experience was among those elected to office and he was placed in charge of the department of streets and public improvements as director, under which the engineering forces were attached. The value of this kind of data made instant appeal

CITY OF TRENTON N.J.

Department of Streets & Public Improvements

STREET MAINTENANCE COSTS

Kind of Pavement	Date Paved	No. Yds.	Price Per Yd.	Contractor	No. Years Guaranteed	Depth of Wearing Surface	Depth of Binder	Foundation	Depth of Sand Cushion.	Kind of Grout.	Kind of Brick
Trinidad Lake Asphalt	Dec 15, 1903	7110.9	$2.06	Barber Asp Pav. Co	5	2"	1"	Concrete 6"			

Year	No. Yds. Repaired	Price Per Yd.	Contractor	Remarks	COST OF MAINTENANCE		
					Repairs	COST PER SQ. YD. PER YEAR	AVERAGE COST PER SQ. YD. PER YEAR
1909	11.00	$1.35	Filbert Pav. & Con. Co.		$14.85	$.00209	$.00035
1910	0.00	0.00	—		0.00	00000	00029
1911	20.57	1.59	Newton Paving Co.		32.70	.00460	.00084
1912	114.20	1.28	City Plant		146.18	.02056	00303
1913	2.42	1.50	Newton Paving Co.		3.64	.00052	.00278
1914	11.84	1.34	City Plant		15.87	.00223	.00273
1915	32.21	1.44	City Plant		46.38	.00652	.00304

DIVISION ST From HAMILTON AVE. To ROEBLING AVE.

Form A-3

CITY OF TRENTON, N. J.

ONE-DAY TRAFFIC RECORD

(Form 2)

12 hrs., from 7 A. M. to 7 P. M. Date _____ 19__ Day of Week _____

Location of observer _____ Ave., St., between _____ Ave. St. and _____ Ave. St.

Width of roadway between curbs at place of observation _____ yds.

Effective traffic width (1 yd. less than full width) _____ yds.

CONDITION OF SURFACE: wet, dry, dirty, clean, slushy, covered with _____ in. snow, _____

WEATHER: rain, clear, foggy, dry, snowy, _____

TEMPERATURE: _____° F. (approximate average).

KIND OF PAVEMENT _____

QUALITY OF SURFACE: new, old, even, slightly uneven, very uneven, _____

STREET CAR TRACKS: single track, double track, _____

KIND OF RAIL: tee, grooved girder, flanged girder, _____

KIND OF PAVING IN TRACK AREA: _____

APPROXIMATE SPEED OF { HORSE VEHICLES: _____ miles per hr. / AUTO VEHICLES _____ miles per hr.

REMARKS: _____

BETWEEN HRS	Horse Vehicles			Total Horse Vehicles	Total Auto Vehicles	Total Number All Vehicles	Tons Horse Vehicles	Tons Auto Vehicles	Total Tons All Vehicles	Total Tons per yd. of effective width	Total Vehicles per yd. of effective width
	1-horse	2-horse	3-horse or more								
7 A. M. to 8 A. M.											
8 " 9 "											
9 " 10 "											
10 " 11 "											
11 " 12 M.											
12 M. to 1 P. M.											
1 P. M. to 2 "											
2 " 3 "											
3 " 4 "											
4 " 5 "											
5 " 6 "											
6 " 7 "											
Totals for 12 hrs.											

Weight Assumptions:
1-horse vehicles average 1 ton.
2 " " " 2 tons
3 " " " 4 "
Auto " " 1¼ "

Observer

FRONT PAGE OF RECORD SHEET.

TRAFFIC CENSUS.

STATION _____ SURFACE { WET—DRY / CLEAN—DIRTY

WEATHER { RAIN—SNOW / CLEAR—FOG

DAY _____ DATE _____ 191 HOUR _____ A. M. P. M.

TEMPERATURE _____ °F

	HORSE DRAWN	
1-HORSE		
2-HORSE		
3 OR MORE		
	LIGHT MOTOR	
2-3 PASS		
MOTOR CYCLE		
	HEAVY MOTOR	
4 OR MORE PASS. LIGHT TRUCKS		
HEAVY TRUCKS, &c.		

OBSERVER

BACK PAGE OF RECORD SHEET.

to him, when the suggestion that such records be made was presented, and since that time maintenance and traffic records have been kept, altho at first the utility of the traffic census was questioned.

A reproduction of the form used for recording the information is shown herewith with the traffic record on the reverse side. The forms for tabulating data collected by observers and the units used are those which the Committee on Traffic of the American Society of Municipal Improvements, recommended for adoption, in 1912. We believe, however, that the weights assigned for the various classes of vehicles should be revised in some particulars, after our experience in using them.

It is quite probable that the lack of data on maintenance costs and traffic records can be ascribed in many instances to obstacles over which the engineering departments have very little control or influence, as for example the condition which obtained in our own city prior to the change in form of government. There seems to be no question but that the more cumbersome forms of administration militate against advanced and progressive ideas in many respects.

The following scheme for recording traffic is presented, as a workable plan, which may be utilized in cities where difficulty is encountered in obtaining help and funds required to collect the data relative to traffic. The idea is simply given for what it is worth. In Trenton this difficulty was overcome in a unique way and the scheme worked very satisfactorily and enabled us to collect valuable information which would have been impossible under any other conditions.

The suggestion was made that high-school students who were contemplating or considering engineering as a career or profession might be pressed into service, because the work was primarily engineering and should appeal to them. The idea was presented to the principal of one of the high schools with an explanation of just what the information was to be used for.

The principal thought the idea a capital one, and immediately agreed to co-operate to the fullest extent. He arranged the periods of the classes in such a manner that an ample

CITY OF TRENTON, N. J.

FINAL CONSOLIDATED TRAFFIC RECORD

(Form 3)

Period observed: _____ days of 12 hrs. each, 7 A. M. to 7 P. M Date _____ 19____

Days of week _____

Location of observer _____ Ave., St., between _____ Ave. St. and _____ Ave. St.

Width of roadway between curbs at place of observation _____ yds.

Effective traffic width (1 yd. less than full width) _____ yds.

CONDITION OF SURFACE: wet, dry, dirty, clean, slushy, covered with _____ in. snow, _____

WEATHER: rain, clear, foggy, dry, snowy, _____

TEMPERATURE: _____° F (approximate average)

KIND OF PAVEMENT _____

QUALITY OF SURFACE: new, old, even, slightly uneven, very uneven, _____

STREET CAR TRACKS: single track, double track, _____

KIND OF RAIL: tee, grooved girder, flanged girder, _____

KIND OF PAVING IN TRACK AREA: _____

APPROXIMATE SPEED OF { HORSE VEHICLES. _____ miles per hr / AUTO VEHICLES: _____ miles per hr.

REMARKS: _____

DAYS	No. of Vehicles		Total Number All Vehicles	Total Tons Horse Vehicles	Total Tons Auto Vehicles	Total Tons All Vehicles	Total Tons per yd. of effective width	Total Vehicles per yd. of effective width
	Horse	Auto						
First day								
Second day								
Third day								
Fourth day								
Fifth day								
Sixth day								
Totals								
Average per day of 12 hours								

Weight Assumptions:
1-horse vehicles average 1 ton.
2 " " " 2 tons
3 " " " 4 "
Auto " " 1¼ "

Compiled by _____

number of recorders was available at all times. The students were used in conjunction with the few men available from the department. In many cases the boys were on the job at 7. a. m., and on Saturday afternoon, as the census was continued for one week. The hourly tally cards used by the students were printed by them in their own shop, which was attached to the school. This printing they volunteered to do themselves, without any suggestion on our part.

Forms used by students are reproduced herewith, as well as the daily and weekly summary forms. The forms for students' use had to be made just as simple as possible, as boys of this age are not expected to use the judgment or have the experience which could be looked for in experienced observers, but taken all together the plan worked out excellently and the work was thoroly enjoyed by the pupils.

It is to be hoped that more thought and study will be given this important factor in the study of road and pavement economics. As matters now stand serious study must be given to the forms and especially the units to be adopted.

SUMMARY OF TRAFFIC RECORD.

W. HANOVER ST. from CALHOUN to PASSAIC.

Year	Av. no. Auto vehicles per 12 hr. day.	Av. no. Horse vehicles per 12 hr. day.	Total no. all vehicles per 12 hr. day	Vehicles per yard of width	Tons per yard of width	Remarks
1915	410.6	250	558	60.4	80.1	Census taken in early Spring.

CITY PLANNING FOR BRIDGEPORT, CONN.

By John Nolen, City Planner, Cambridge, Mass., and Frank B. Williams, Attorney at Law, New York.

TO THE student of civics seldom if ever has any city presented problems so numerous, so important, or so varied, as does Bridgeport today. The typical new boom town and its failings we know; the old city and its difficulties are always with us; but not until the advent of the munition business of the present war have we encountered, in an acute form as in Bridgeport, boom city problems and old city problems combined and interrelated.

"Before war was declared in Europe, Bridgeport had a population of about 102,000. Today, it has nearly 150,000, a phenomenal increase of nearly 50% in twenty months. It has not yet reached its maximum, and this gain will undoubtedly continue until the city has at least 200,000 population. * * * One concern, it has been publicly stated, has made an investment in Bridgeport in new factories, land, machinery, etc., of $20,000,000 or more. Other local industries have grown proportionally."

Such growth causes, in Bridgeport, the evils that it causes in any city, new or old, in which it occurs,—rising rents, scarcity of houses, of schools, of play and recreation grounds—scarcity, in short, of all the facilities of city life; and the disorder and immorality that seem so inevitably to follow in the wake of stunted municipal life. No wonder the report asks the pertinent question:

"It has been said that a new man is employed in Bridgeport every ten minutes, and one is tempted to inquire what is being done every ten minutes to provide this new citizen with the essentials of city life?"

These are the problems so commonly found in boom cities. In Bridgeport they are complicated and made more acute and difficult of solution by the problems typical of the old city. The business centre is not only congested, but firmly established and rigidly confined in its narrow limits; the slum areas, also fixed, are still more over-crowded; the inadequate houses, being also in many cases old, are still less able to house decently the increased numbers that crowd them.

Under these circumstances, in Bridgeport as elsewhere, the difficulties to be overcome are, by many people, regarded as entirely housing problems. If housing in its complete sense is meant, this is, no doubt, true; otherwise nothing could be more false. The construction of houses and nothing more is a mere palliative; the only cure is the increase also along right lines, of all the municipal facilities—streets, sewers, parks, etc.; a wise regulation of all future building; and a change, so far as absolutely necessary, in the framework of the old city so as to remove the most hampering of its faults and limitations due to its constructions, such as the narrowness of some of its main thorofares, the congestion of its business centre, etc. This is city planning; and fundamental city planning is perhaps the one thing that cities are slowest to see the need of and do.

Bridgeport not long ago issued a report, by Mr. Nolen, entitled "More Houses for Bridgeport;" and, soon afterwards, a $1,000,000 corporation was formed to build them. The present report shows that she has also begun to face the more fundamental city planning difficulties which beset her.

The following passage from the introduction to the second or legal part of the report, by Mr. Williams, indicates its necessity, its purpose and its scope:

"In order better to meet this exigency, Bridgeport has caused a survey of her situation to be made. The reports of Mr. Nolen and myself now submitted state the results of that survey, with recommendations, based on it, for the improvement of that situation. Mr. Nolen's report is occupied with the physical aspects of the subject, while mine is concerned with its no less important legal aspects. In a democracy like ours, no public enterprise can be accomplished except by methods sanctioned by law.

"This report will first take up the legal problems with regard to the planning of that part of Bridgeport and its environs which is at present within the legal limits of the city. In so doing it will deal first with the question of the city planning agency or executive for the city, its membership and powers: Secondly, with various specific legal powers which the city needs in its planning as follows: the adoption of a city plan, excess condemnation; building regulation and districting; Thirdly, with the financing of Bridgeport's city planning; Lastly, with the planning of greater Bridgeport, so intimately connected with the problems involved in the planning of the present city.

"The legal proposals of this report are all urged as more or less specific aids in carrying out the suggestions contained in Mr. Nolen's report for the improvement of the physical situation in Bridgeport. But this is not their sole purpose. It is hoped that the measures advocated in this report are also those legal measures of which in her planning Bridgeport is most in permanent need."

THE MILL CREEK SEWER

TUNNEL CONSTRUCTION ON THE GREAT ST. LOUIS DRAIN

By E. J. Rossback, 32 Ave. des Champs Elysees, Paris, France.

This article is a valuable practical contribution to contractors' practice in driving and lining drainage tunnels, showing how the work was done by the several contractors to whom the sections were awarded.

The Mill Creek Valley sewer at St. Louis, Mo., was constructed to handle storm waters and intercepts the existing system.

General Features.

The sewer has its beginning at Duncan and Vandeventer streets and follows roughly an east and west line to its mouth in the Mississippi river at the foot of Rutger street. Its total length is 20,040 linear feet, the first 2,000 feet west from the river being open cut and the remainder in tunnel. The tunnel has a section of horse-shoe shape, with pay lines 19 by 19½ feet. The cubic yardage per running foot is 11.75 and the estimated quantity of excavation in tunnel was 208,000 cubic yards.

Description of Sections.

The Carter Construction Company, of New York, the successful bidder on the entire job, divided the work into four sub-contracts, one open cut and three tunnel sections. The American Contracting Company of St. Louis was awarded the open-cut sub-contract, from the river to Broadway, 2,000 feet. The McMahon Construction Company, also of St. Louis, was given the next 5,000 feet, to 18th street: Brocklehurst and Potter Company, of New York, undertook the next 6,500 feet to Virginia avenue, and Thomas Connor & Sons had the sub-contract on the last 6540 feet to the end of the sewer at Duncan and Vandeventer streets. The line of work intersected a railroad, manufacturing and residence district, just south of the main business arteries of St. Louis. This made the disposition of the material excavated somewhat of a problem and expense. Blasting, also, was attended with some restrictions.

Thomas Connor & Sons.

Thomas Connor & Sons found their section to contain 600 feet of soft ground, and 5940 feet of rock.

Their driving was handled thru three working shafts proper. In addition, one connection, known as the Rock Springs connection, was started from a small shaft, and one manhole was sunk just across Vandeventer avenue from the Duncan shaft.

This sub-contract involved approximately 100,000 cu. yds. of excavation (running over the engineer's estimate), 25,000 cu. yds. of concrete and 4,000 cu. yds. of brick masonry.

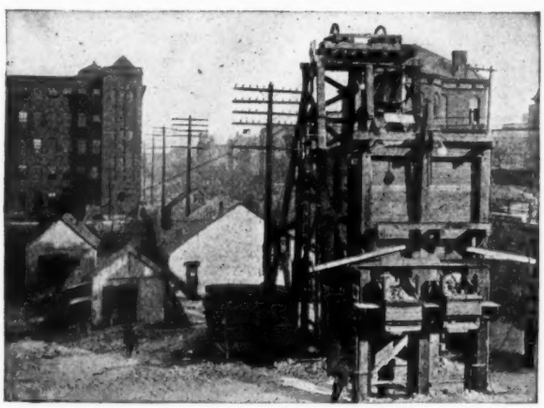
Work was begun on the shafts about November 15, 1914, the headings were turned about December 15, 1914, excavation was finished July 25, 1915, and the concrete lining was completed on December 20, 1915.

Shaft Construction.

The shaft at Theresa and Chouteau streets is 112 feet deep and has inside dimensions of 12 by 16 feet. The Tamm shaft is 94 feet deep with the same inside dimensions. It was started thru "made" ground and sheet steel piling was driven to the rock. The Duncan avenue shaft was next sunk by the open caisson method. It has a diameter of 16½ feet and is 88 feet deep. The last 34 feet was curved from the vertical to the horizontal on a 25-foot 9-inch radius. The Rock Springs connection shaft was sunk somewhat later. It has an inside diameter of 10 feet and is 94 feet deep, and was also sunk by the open caisson method. Just before completion of the excavation a manhole 6 feet in diameter was sunk opposite the Duncan shaft to serve permanently as a means of access to the sewer. This is 88 feet deep. All shafts were sunk with self-rotating hammer drills. All were equipped with double compartments and single-drum electric hoists, except the Rock Springs shaft and the manhole. The former was equipped with scale boxes and an air-operated hoisting engine of the usual construction type and the latter with buckets.

Tunnel Methods.

The drive west from the Tamm shaft included 400 feet of quick-sand, while that eastward involved 200 feet of soft clay. Both of these soft-ground sections were handled without air pressure. Quicksand in the tunnel roof was supported by grouting and driving sheeting, a small pilot heading being driven in the center of the top of the tunnel section. Much difficulty attended this sheeting work because the quicksand rested on clay which contained limestone boulders. The bench consisted of more or less solid limestone. Great credit is due the contractor for the really ingenious manner in which the difficulty was overcome. Twelve by twelve timbers were placed skin to skin, 12-ft. to 16-ft. wall plates being employed. The spaces between the timbers were tightly calked with oakum. Some idea of the weight supported by these timbers, due to the unequal ground pressure in this formation, may be gained from the accompanying illustration. This shows 5-segment, 12 by 12 timbering with the wall plates carried on solid rock benches. Several segments began to give way and required temporary supports as shown. Part of the timbering west of the Tamm shaft was on rather a sharp curve and the accurate manner in which it was placed speaks well for the ability of the men in charge. The clay east of the Tamm shaft presented a somewhat less difficult task, altho the boulders in the clay made the work troublesome. Three 8-hour shifts were worked most of the time while driving thru the soft ground. One hundred feet of 21 by 9 feet heading, all in soft material, was driven from the Rock Springs shaft. This was timbered



COMPRESSOR HOUSE AND HEAD FRAME, ARMSTRONG SHAFT, BROCKLEHURST AND POTTER.

solid, and the bench, all in rock, removed from the Tamm shaft.

The rock encountered in this sub-contract was partly the characteristic Mississippi limestone prevalent about St. Louis, and partly a tough, silicious, blocky and seamy limestone. The latter gave considerable trouble in the heading, but drilled very well in the bench, due, no doubt, to its horizontal stratification.

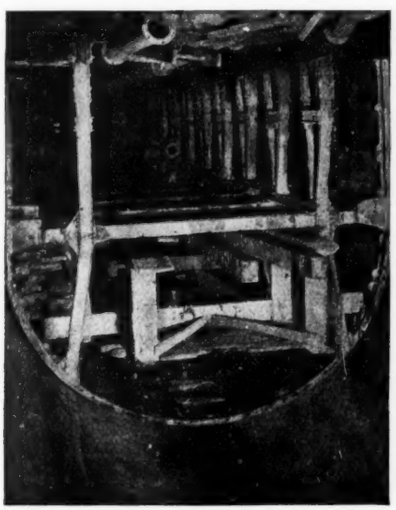
A top heading 7 feet high was driven, constituting about 30 per cent of the cross section, followed by a 3-foot bench and a 9-foot sub-bench. The benches were kept as close as possible to the heading to minimize the length of the wheelbarrow haul from the heading. All mucking was done by hand labor and was the determining factor in the progress rate, the heading being shut down from time to time to allow the bench to catch up.

Drilling the Headings.

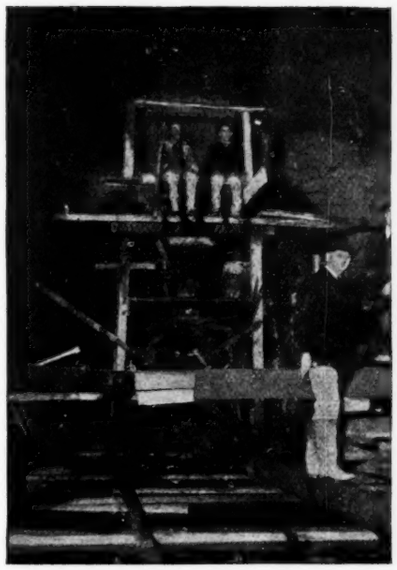
The heading was drilled by two drills mounted on two columns, one on either side. Each drill was operated by a runner and helper. The heading round consisted of from 18 to 24 holes, six to eight of which were center "V" cut holes. Two relief holes in the center of the cut were drilled and shot simultaneously with the cut holes in the hard rock with excellent results. The depth to which the heading holes were drilled varied with the conditions, 8 to 12 feet being the usual range of the cut holes. The heading rounds pulled from 6 to 9 feet as a rule, altho an advance of break of 11 feet was recorded. Six to seven hours were required on the average to drill the heading round. Two self-rotating hand drills drilled the bench and sub-bench, the holes being spaced about 4 feet back and 4 feet apart. This spacing was closer than necessary to break the bench, but was found advantageous in order to avoid sledging. One-inch 60-per-cent forcite was employed in both heading and bench. All shots were fired electrically from a switch on the timber head frame.

Sullivan Liteweight 2⅝-inch water drills were used in the headings at the beginning of the work, but were later replaced in part with mounted water-hammer drills, which proved superior in efficiency in the silicious limestone. This was characterized by flint nodules and presented a really tough tunneling proposition. Six Sullivan "DR-6" type drills were used in this work with excellent results and to the complete satisfaction of the contractor.

The record for driving in rock (made in the section east of the Tamm shaft) was 116.2 feet of heading and bench in 13 ten-hour shifts, and average progress of a trifle less than nine feet per shift. The average daily progress in each heading and bench (two 10-hour shifts) was 11.5 feet. The longest drive in one direction from any shaft on the job was approximately 2,000 feet (west of Theresa shaft). This required from January 1 to August 1. Four hundred and two feet of completed tunnel section were driven east from the Tamm shaft in 56 10-hour shifts.



PORTABLE STEEL CONCRETE FORMS IN PLACE. BRACING FOR THE ARCH.



HOPPER AT FOOT OF WELL DRILL HOLE FROM SURFACE, AND PNEUMATIC CONCRETE MIXER.

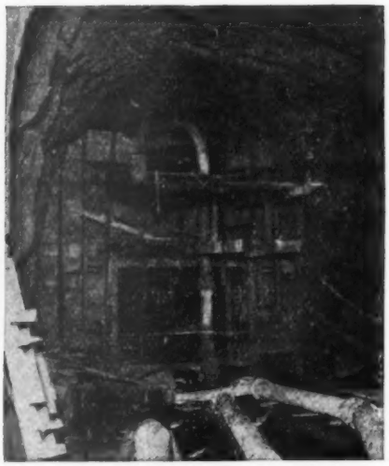
Air Compressor Equipment.

All of the power used was derived from electric current, furnished at 220 volts, three-phase, 60-cycle by the Union Electric Company of St. Louis at a remarkably low rate, somewhat under one cent per kilowatt-hour. The air plants consisted of two class WJ cross compound belt-driven Sullivan air compressors, having a displacement of 1,008 cubic feet per minute each, one located at Theresa and one at Tamm shaft. These machines did excellent work thruout the job, running 48 days continuously without a shut-down on a number of occasions. They delivered air at pressure ranging from 90 to 120 pounds per square inch.

All of the muck was handled from the shafts by team, the hauls being short (not over one-half mile each way from any shaft). Most of the rock muck was crushed either in a plant near the Theresa shaft, consisting of one No. 5 gyratory crusher, or in the one near the Tamm shaft, consisting of a No. 3 crusher. It was then sold, or stored for use as the aggregate for the concrete lining. The balance of the rock muck and the soft muck was dumped in a lot as filling.

Pneumatic Lining Method.

The concrete lining was placed by the pneumatic method, with the exception of the invert, which was placed from cars. The success with which the pneumatic method was attended is shown by the following records. The best performance was the placing of 640 feet of lining in 127 hours of actual operation. In September, 1915, 1,880 linear feet of lining was placed in 46 10-hour shifts, 680 feet of which was placed in 13 shifts, or one week. In October, 1915, 1,753 feet was lined in 46 shifts, which performance is noteworthy because of the



CONCRETE FORMS BULKHEADED, AND CONVEYOR PIPE FROM PNEUMATIC MIXER.

fact that this stretch contains two sharp curves. It may be mentioned in passing that the tunnel section was very closely adhered to in the driving, the overbreak representing not over ¾ cubic yard per linear foot of tunnel. Forty-foot standard steel forms were employed in the pneumatic concreting. The mixing apparatus was furnished by the Concrete Mixing and Placing Company.

The working day consisted of two 10-hour shifts except in the soft ground, as noted previously. An abundance of labor was available at all times, aiding to reduce the cost of the work. Powder was also considerably cheaper when the contracts were made than at this time. In the neighborhood of $40,000 was saved by the Connor Company alone, as against present prices.

The cars used were 1¾ cubic yards water measure. Pipe scaffolds were employed to support the runway from the heading to the end of the sub-bench.

Brocklehurst & Potter Section.

The section of the Mill Creek sewer sublet to the Brocklehurst & Potter Company was the middle 6,500 feet of the tunnel, and was characterized by almost ideal conditions. It was practically dry, all pumping being handled by 7 by 5 by 13-inch air-driven piston pumps at each shaft, operated only between shifts; it was possible to drive the sub-bench and bench 100 feet without losing a ledge, or stratification plane to which to break, thus making mucking less arduous. No soft ground was encountered and the formation was the characteristic Mississippi limestone thruout.

The tunnel was driven from three shafts, one at Armstrong street, another at Montrose, and the third at Ohio street, six headings being operated simultaneously. Eighty thousand cubic yards of rock excavation were involved (3,000 of which were shale). The concrete lining amounted to 25,000 cubic yards.

The Armstrong shaft, 15 by 19½-foot rough, 12 by 12½-foot inside the lining and 95 feet deep, was begun October 29, 1914, and headings were turned on December 17. The Montrose shaft has the same dimensions as the Armstrong and is 79 feet deep. This was sunk by the open caisson method. It was begun on November 25, 1914, and the headings were turned January 5, 1915. The last, or Ohio shaft, also a drop shaft, single compartment, 9 by 12½ feet rough and 6 by 9 feet lined, 77 feet deep; was begun on February 2, 1915, and the headings were turned on March 8, 1915. The first two shafts each contained two compartments. The longest distance between shafts is 1,500 feet.

As on the Connor job, the top heading, bench, and sub-bench system was employed, the heading being 9 feet, the bench 3 feet, and sub-bench 7½ feet high. Hand mucking again proved the limiting factor as regards progress on this job, as on the one described above. The cars were of 1 2/3 cubic yards capacity water measure.

Driving with Hand Hammer Drills.

Of the six headings, one was drilled with Liteweight 2⅝-inch water drills, one with drills of a mounted water-hammer type and the other four with self-rotating hand hammer drills of the DP-33 type, held to the face by hand by two men. In each of the first two headings, the equipment consisted of four drills mounted on two columns and three hand-hammer drills for the benches. Five hand-hammer drills were used in each of the other headings. The bench holes were spaced as on the sub-contract described above. The headings were also drilled in similar fashion, 18 to 24 holes being used. A normal round consisted of 6 center V-cut holes, and two sets of eight holes each constituted the side rounds. The drilling time varied from 4 to 6 hours. A hammer cut was employed at times when the conditions of the heading were suitable.

The average completed tunnel excavation per working shift from the time the headings were turned was 4.4 linear feet for the entire job, and, from the time the cages were installed in the shafts, the average advance per shift was 5.1 feet. An advance or break of 8½ feet in one heading in one shift was recorded, altho the average break in the headings was about 5 feet. Sixty per cent, 1-inch forcite was used on this job also, for heading and bench. The best sustained records were made from the Montrose shaft. The west heading and benches were advanced 1,472 feet in 298 shifts, a progress of 4.95 feet per shift. The east heading and benches were advanced 947 feet in 166 shifts, a progress of 5.77 feet per shift.

Concreting Work.

The lining was placed, as in the case of the Connor job, by the pneumatic method. From July 19 to December 9, 1915, 1,928 working placing hours, 163 forms 40 feet long were concreted. This work involved the handling of 18,000 cubic yards of concrete and extended for a length of 6,261 linear feet. Eight different set-ups of the "gun" were required, the time for the set-ups being subtracted from total shift time to arrive at the above number of hours of placing. Eighty-nine cubic yards were placed per 10 hours of steady shooting and 73 cubic yards per 10-hour working shift, total time. The best work was done when 737 feet of tunnel was lined in 13 10-hour shifts, making a record of 144 cubic yards placed per shift of total time. Four forms were used as against three on Connor's work.

On the other sub-contracts, the concrete mixers were situated in the tunnel and the materials conducted to them by feed pipes dropped thru well-drill holes which had been bored for the purpose of checking the tunnel alinement. On the Brocklehurst and Potter job, the concrete was mixed on the surface and conducted thru the drop pipe to the "gun." The power of the rotator hammer drill was demonstrated interestingly in this connection. One of these pipes, dropped thru a 12-inch hole 57 feet deep, clogged, and the concrete set at a point 38 feet from the top.

After vain efforts to dislodge this mass of concrete, a 38-foot rod of 1-inch-round iron was made into a drill by welding on a ⅞-inch hexagon shank at one end and a cross bit at the other. This was lowered into the hole and put to work with a self-rotating hand drill. The first drill tried failed to make any progress; but when a Sullivan rotator was substituted, the 6-foot concrete plug was penetrated in two minutes. Two

sticks of dynamite, 60 per cent, were then lowered to the center of the plug and shot with an electric exploder, shattering the concrete so that what remained was easily removed from the walls of the drop-pipe with a hand churn drill.

Motor Trucks for Disposal.

The muck was disposed of in similar fashion to that noted above. The shale was wasted in a dump. The solid rock was hauled by 5-ton motor trucks, to a crusher plant and storage pile. The haul was 1.3 miles each way, on the average. The trucks gave a splendid account of themselves, working 24 hours per day with the exception of Sundays. The contractor estimates that approximately 25 cents per yard was saved thru the use of the trucks as against teams. This saving was in part due to the self-dumping feature of the trucks.

Ventilation.

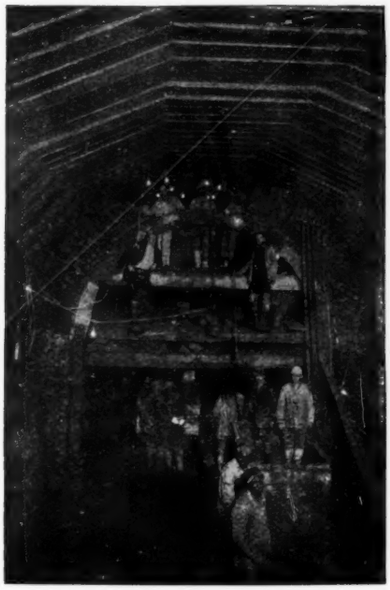
The blower equipment for ventilating the tunnel may be of interest as it is typical of that used on the other sections. It consisted of two electrically-driven No. 5-B blowers, rated at 2,000 cubic feet per minute, one each at the Armstrong and Ohio shafts, and one No. 8-B blower, rated at 6,000 cubic feet, at the Montrose shaft. The air was carried to the face by collapsible canvas tubes hung in hoops at the side of the tunnel. Powder smoke gave some trouble early in the job, but this was soon overcome.

All plant equipment was electrically driven with the exception of the pumps. Each shaft was provided with an electric hoist, and two 1,000-foot class WJ cross-compound air compressors were installed at the Armstrong shaft, air being piped to the other two shafts. The air pressure was maintained at from 90 to 120 pound gage. These compressors also gave noteworthy satisfaction. Only one delay could be charged to these compressors and that was only of a few minutes' duration and was occasioned by the breaking of a belt splice. These machines also operated continuously, at 24 hours per day, for long stretches of time without any sort of a shutdown.

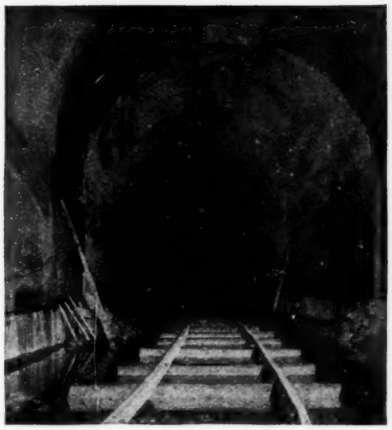
All tunnel excavation was completed on July 15, 1915, concreting was begun on June 20, and finished December 9, 1915.

McMahon Construction Company.

The James T. McMahon Construction Company executed



12x12 TIMBERS SET "SKIN TO SKIN," AND BEGINNING OF THE BRICK LINING IN SOFT GROUND SECTION.



COMPLETED AND LINED SECTION, MILL CREEK TUNNEL.

the work just west of the open cut section for a distance of 5,000 feet, 750 of which consisted of soft ground.

This work was handled thru two working shafts, one at 6th street and the other at 12th street.

The sub-contract involved 65,000 cubic yards of excavation 12,000 cubic yards of concrete lining and 3,000 cubic yards of brick masonry. Work was begun on the 6th street shaft on November 29, 1914, and was completed in 11 days. The 12th street shaft was begun on the 25th of November, 1914, and completed on January 1, 1915. The heading west from 6th street was turned about December 1, 1914, and the two headings were turned, east and west, from the 12th street shaft about January 3, 1915. Both shafts are 12 by 16½ feet inside of the lining. The 6th street shaft, 40 feet deep, was arranged for single compartment hoisting and the 12th street shaft, 90 feet deep, had two compartments. Both shafts were sunk with Sullivan class DP-33, self-rotating hand-hammer drills.

Soft Ground and Timbering.

The excavation in the four soft-ground sections carried about 16 cubic yards per running foot and consisted of soft clay, containing many limestone boulders. It was impossible to drive sheeting thru this formation. The section just west of 12th street was very wet, a stream of water pouring down from the top pilot heading. The timbers were 12 by 12 inches, set either skin to skin or on 30-inch centers. The timbering in this section was exceptionally well done and presented a most pleasing appearance. (See illustration.)

The rock on this sub-contract was the characteristic Mississippi limestone, with the exception of a section near the west end of the job, where flint nodules gave difficulty in drilling. A bottom heading 8 by 13 feet was used except in the soft ground section.

Piston Drills in the Headings.

The heading was drilled by four Liteweight 2⅝-inch water piston drills on two double screw columns. For the breakdowns and wings, self-rotating hand hammer drills, class DP-33 were employed. The heading round consisted of 22 to 24 holes, eight of which were center "V-cut" holes. Both cut and side round holes were drilled from 7 to 9 feet deep, giving an average break per shot of 4.5 feet. The heading was shot twice per shift and at times five times in two 10-hour shifts.

The average heading progress was about 18 feet each 24 hours. The breakdowns and wings were shot, as desired, to equalize the amount of muck that could be handled. Jumbo

timbers were set up in the bottom heading and the breakdown shot onto them.

The muck from the breakdown was then dropped into 2-yard cars placed below the timbering. The bottom heading system was found to lend itself with special advantage to the handling of the work whenever soft ground was encountered, and it became necessary to drive up and start a pilot heading. Under these conditions, the practice was to drop back and work upon the wings and breakdown, thus maintaining a uniform output of muck from the shaft. The powder cost under this system was also pleasingly low. The powder consumption in the headings was 4 pounds per cubic yard, and in the breakdowns and wings ½ pound per cubic yard.

The Sullivan FF-12 water drills used in the headings gave a very satisfactory account of themselves and easily handled the drilling for two shots per 10-hour shift. In some instances the total time per shift, during which air was on the drills, was as low as one hour and thirty-seven minutes. When the flint nodules were encountered in the heading, a mounted water-hammer drill, class DR-6, was used for a distance of about 150 feet at the western end of the job, and handled this difficult formation to excellent advantage. The self-rotating hand-hammer drills did rapid and efficient work in shaft sinking, in the breakdown, wings and for drilling the boulders found in the clay.

The tunnel excavation was completed about December 1, 1915, altho concreting had begun in certain sections about August 1, the same year. The best week's driving record in the heading was 140 feet. A 5-foot section of heading between 6th and 12th streets, averaged 105 feet per week. Very little trimming was required and the over-break was unusually low; between 6th and 12th streets being under the allowance of 6 inches.

Power Plant.

All of the power used on this job was electric current at 220 volts, 3-phase, 60-cycle, furnished by the Union Electric Company of St. Louis, as was the case on the other sub-contracts. All equipment, including the hoists, was driven by motors. The air plants consisted of one Sullivan WJ cross-compound short-belt-driven air compressor, located at the 12th street shaft, and one 628-foot angle compound WJ-3 Sullivan compressor at the 6th street shaft. A second 628-foot WJ-3, also short-belt-driven, was purchased later and used for a time at the 6th street shaft and then moved to the 12th street shaft, when concreting was first begun. These compressors gave the same excellent satisfaction as was recorded on the other sub-contracts. The air pressure varied from 100 pounds per square inch gage to 125 pounds.

All muck was handled from the shafts by teams, the hauls from all the shafts to the crusher plants not exceeding one-half mile for the round trip. The concrete lining was placed by the pneumatic method with the exception of the invert, which was placed from cars. A record of 50 ¼-yard batches per hour of shooting time was recorded.

This job contained some rather wet sections and about fifteen hundred million foot gallons were pumped per month. A centrifugal pump was employed at 6th street and piston pumps were in use at the 12th street shaft.

The cars used were 1¾-yard water measure. One-inch, 60 per cent dynamite and No. 6 caps were used. All blasting was done electrically, a switch being placed at the collar of the shaft.

It may be of passing interest to note that the 2,000 feet of open cut just west from the Mississippi river contained 50,000 cubic yards of very close excavation and 11,000 cubic yards of concrete work. This work was handled by the American Contracting Company.

In concluding, the writer begs to thank the officials of the Carter Construction Company, of Messrs. Thomas Connor & Sons, of Brocklehurst & Potter, and of J. T. McMahon Construction Company, for courtesies received in the preparation of these accounts.

Massachusetts Municipal Electric Plants Show Gains

A largely increased business, with a proportionate growth in income, is reflected in the annual returns of Massachusetts municipal electric light plants, as filed with the Gas and Electric Light Commissioners for the year which ended June 30, 1916. A study of several of the larger plants, which generate energy at their own stations either wholly or in part, shows that the gains in output of the municipal undertakings in the state are fully commensurate with the growth of company business, over the year 1914-15.

In the table of operating data, the amounts and cost of coal used are presented. Prices for fuel vary, of course, with the freight rates, the plants located on tide water enjoying the advantage of lower costs. While a comparison of total costs of energy generated and distributed needs all the factors entering into the local situation to represent a valuable study, yet the appended table of total costs per kilowatt-hour may be of interest. Generally, the larger the volume of energy generated, the lower the cost of production; and the same is true with respect to cost of distribution, power used in the larger units, and lighting supplied in larger quantities per meter, representing the minimum of cost for this item. The lowest cost, that for the Holyoke plant, is due in part to the fact that the energy is in large part hydroelectric, while the comparatively low costs at Taunton and Danvers are due in part to the fact that these plants enjoy the advantage of water-borne coal. Distribution represents, of course, a large factor in the operation of any elctric plant, and the higher figures given represent residential communities, where the energy is used in small units by householders, and the power load is not an important item. In comparison with the total cost of production and distribution for the Massachusetts municipal plants it is interesting to note the corresponding costs, fixed charges excluded, for electric light companies operating in towns and cities of about the same size. These figures, in contrast, form an excellent commentary on the efficiency of management and operation with which municipal plants in the state are being conducted.

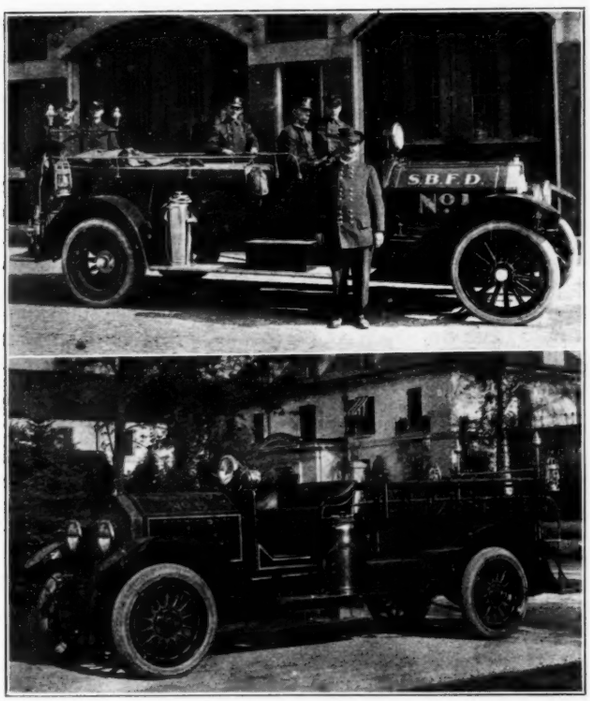
The Taunton plant's showing is also excellent. Here the output was increased 1,300,000 units, or 31.5 per cent, while expenses were only 15.8 per cent more than for the year 1914-15. In this city of foundries and stove works, the power load gained 830 connected horsepower, a considerable part of this being a motor installation in a foundry works which recently located in the city.

The Reading plant also shows important increases, especially in its lighting load. The kilowatt-hour output increased nearly 25 per cent, the income 21 per cent and the operating expense 23 per cent. The profit balance from operation of $16,279 is 34 per cent on the volume of business done. The North Attleboro plant, under the continued management of William Plattner, relied, the past year, principally on purchased power. Only the Westfield plant, of those under consideration, showed a deficit from operation, and this department of the town is now about to be reorganized.

FIRE DEPARTMENT

Mistake About "Hoosier" Pump

The surprising demonstration of power efficiency shown in the recent test of the Hoosier Pump at South Bend, Ind., was—thru a typographical error—misrepresented on page 225 of our December issue. Instead of "250 gallons per minute" as therein stated, the Hoosier Pump has a rated capacity of



350 gallons per minute. The record made with a pump of this capacity is one which fire chiefs will appreciate. The pump in question is made by the South Bend Motor Car Works, of South Bend, Ind.

Middletown, Conn., Is Federalized.

Chief Pitt, of the Middletown, Conn., department, is the oldest fire chief in the State in point of years of service, and he is likewise one of New England's most enthusiastic advocates of completely motorized fire-fighting equipment.

The city of Middletown has two Federal trucks in service, one a chemical combination wagon, the other a 7,500-lb. tractor, which has just been installed.

The following tables, compiled by Chief Pitt, are interesting as throwing more light on comparative operating costs of motor apparatus and horse-drawn equipment:

COMBINATION WAGON FOR ONE YEAR.

Gasoline	$23.84
Oil	2.00
	$25.85
Feed	$297.41
Shoeing	44.25
	$341.66
Alarms answered	56..
Miles traveled	500

7,500-LB. TRACTOR PUT INTO SERVICE APRIL 27, 1916.

Gasoline at 25c	22.80
Oil	1.00
	$23.80
Care of 3 horses—	
Feed	$547.84
Shoeing	72.30
	$620.14

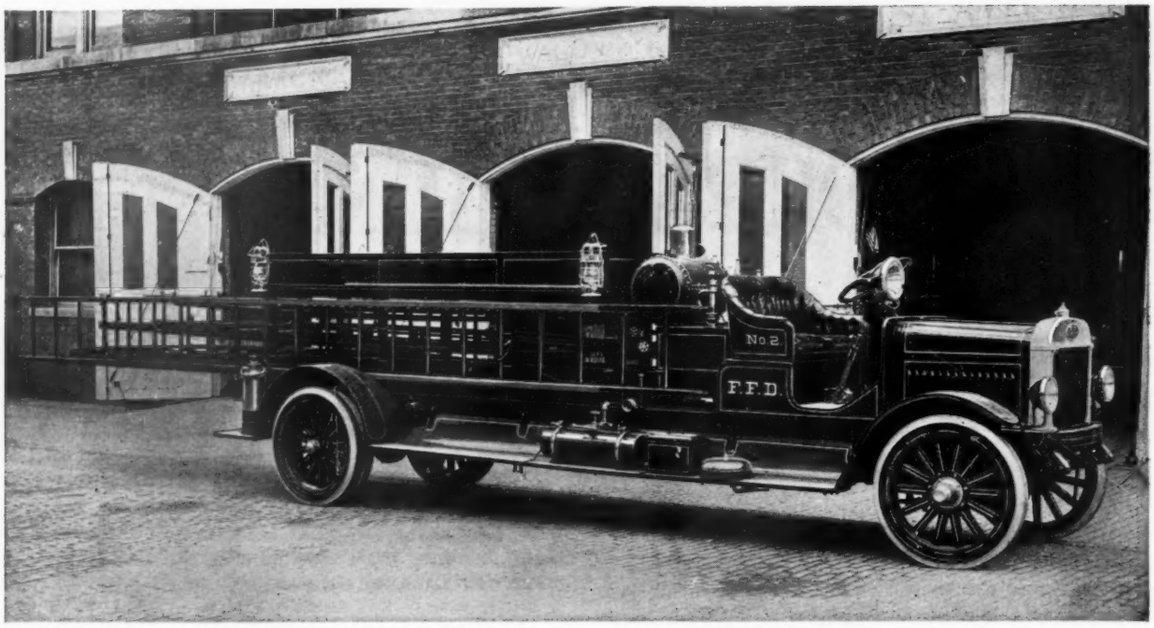
Cost of gasoline and oil for July and August for both the combination wagon and the 7,500-lb. tractor, $2.50.

Trend Is Toward Motorization.

Among the recent installations of Hale motor apparatus are combination chemical and hose trucks (some of them equipped with trussed extension ladders and chemical engines) to the cities of Ashland, Pa.; Excelsior Springs, Mo.; Silver City, N. M.; Monett, Mo.; Moberly, Mo.; New Kensington, Pa.; Claremore, Okla., and Ozark, Mo.

Packard apparatus was recently put into service by the villages of River Forest, Ill.; South Brownsville, Pa.; Baltimore, Md.; Alemeda, Cal., and the boro of Parnassus, Pa. The city of Elgin, Ill., recently purchased two 1½-ton Packard chasses and adapted its old horse-drawn equipment to them "at a slightly lower outlay than was originally planned for investment in a single vehicle."

American-La France motor apparatus is either already in service or are now being built for use by the following Canadian municipalities: Halifax, N. S. (1); London, Ont. (2); Ottawa, Ont. (2); Hull, Que. (1); Lachine, Que. (2); St. John, N. B. (1); Stratford, Ont. (1); Sydney, N. S. (1); Toronto, Ont. (6); Westmount, Que. (1); New Waterford, N. S. (1); Winnipeg, Man. (2). It is noteworthy that most of the



GRAMM-BERNSTEIN 2½-TON COMBINATION CHEMICAL, LADDER AND HOSE TRUCK, AS OPERATED BY THE CITY OF FARRELL, PA. A HIGH PRESSURE AIR TANK IS USED INSTEAD OF THE ACID AND SODA COMBINATION.

foregoing are pumping cars. The city of Toronto now operates two combination chemicals, one service truck, three tractors and has placed an order for still another combination. Other recent deliveries of motor apparatus include the cities of Reading, Pa.; Carbondale, Pa.; Hibbing, Minn.; Paragould, Ark.; Murray, Utah; Steelton, Pa.; San Angelo, Tex.; Sharon, Pa.; Altoona, Pa.; Arnegard, N. D.; Hudson, Minn.; Glasgow, Mont.; Ogden, Utah; Hutchinson, Kas.; Waterloo, Iowa; St. Cloud, Minn.; Marion, Ohio; Lakewood, Ohio; Cornwells Heights, Pa.; Dayton, Ohio (5 pieces); Greeley, Colo.; Battle Creek, Mich.; Muskegon, Mich.; Sioux City, Iowa, and Burlington, N. J.

Note how many of the above departments just motorized are for small town service.

What Baltimore Is Doing.

If the board of estimates of Baltimore, Md., grant the request of the fire board, 4 new engine tractors, 7 new ladder truck tractors and 3 new combination chemical and hose tractors will be purchased for the fire department. There are now remaining in the fire department only 161 horses. If the fire board's request is granted only 99 horses will be in service next year. It is stated the tentative inclination of the members of the estimates board is to allow the new motor apparatus.

Fire Department Notes

Officials of the city of Mt. Vernon, N. Y., have systematically built up one of the most efficient fire departments owned by any city of the same size by the gradual process of replacing its old horse-drawn apparatus with motor fire-fighting equipment. The process of elimination and upbuilding began five years ago when the city purchased its first White combination chemical and hose truck and at least one of these modern fire-fighters has been added to the fleet each year since that time.

Schlingmann of Jeannette

Paul C. Schlingmann, present Fire Chief for the City of Jeannette, Pa., was for 23 years in the service of the Pittsburgh department, retiring as a lieutenant in July, 1914. He has been with the Jeannette department ever since the organization of a paid staff, which came about in February, 1915. He reports that the change from a volunteer to a paid department has worked out very beneficially to the community, saving considerably more in property values than the addition in salaries. The Jeannette department is motorized.

Hitchcock of Council Bluffs.

F. G. Hitchcock, well-known fire chief for the City of Council Bluffs, Ia., joined the local volunteer department as a torch boy in 1878. Ten years later he was appointed on the paid fire department as a truck driver, and in 1892 was made Captain at the Central Fire Station. After eight more years of able service in that capacity he was appointed Assistant Chief, and in 1914, at the age of 54 years, was appointed Chief of the entire department. "A good man and true"—as he often has demonstrated.

Lindsay of Boise City.

C. F. Lindsay, Fire Chief of the City of Boise City, Idaho, has been connected with the department for 17 years past, beginning at the very bottom and working his way steadily up the ladder. He was Assistant Chief for three years and received his appointment as Chief in 1903. He knows his business and does it thoroly. Chief Lindsay's ambition is the complete motorization of his department and he is accomplishing that end by buying one new piece of apparatus each year.

Paul C. Schlingmann C. F. Lindsay F. G. Hitchcock

Motor Apparatus in Fire Departments

(*Continued from December number, page 44 of Motor Truck section.*)

In the second column of this table, in describing combinations, *ae* stands for aerial ladder equipment; *ch*, chemical; *chf*, chief's car; *ho*, hose; *h.p.*, high pressure; *L*, electric; *l*, ladders carried on combination trucks; *ladd*, city service hook and ladder equipment; *mot*, motorcycle; *pp*, gasoline pumping engine truck; *sal*, salvage corps truck; *sq*, squad wagon; *st*, steam pumping engine; *sup*, supply wagon; *tow*, water tower; *tr*, tractor; *tr. ae*, aerial ladder truck hauled by tractor; *tr. la*, hook and ladder truck hauled by tractor; *tr. st*, steamer hauled by tractor; *tur*, turret. *o* in column of "Years service" means that apparatus is new or not yet in service. *p*, pyrene cylinders.

1—Cost of gasoline and repairs. 2—Cost of gasoline, oil and tires. 3—55 gallons gasoline, 3 gallons oil. 4—180 gallons gasoline, 10 gallons oil. 5—40 gallons gasoline, 2 gallons oil. 6—105 gallons gasoline, 4 gallons oil. 7—Difference in cost of repairs in the two machines due to pneumatic tires on one and Dayton airless on the other. Both cars now equipped with Dayton airless. 8—Cost of repairs and gasoline and oil. 9—Materials only; repair work done by drivers or mechanicians in fire department. 10—Cost of repairs for all 28 machines in the department. 11—Cost per horse employed in the department. 12—6 gallons. 13—Sum for four American-La France pumping and combination. 14—These cost figures include all three pieces of apparatus and the cost of gasoline and oil includes also some police apparatus. 15—10 miles of streets in good condition, 5 fair, 15 bad. 16—gallons of gasoline. 17—542 gallons gasoline. 30 gallons oil. 18—121 gallons gasoline, 20 quarts oil. 19—214 gallons gasoline, 75 quarts oil; 20—25 per cent good, 40 per cent. fair, 35 per cent. bad. 21—40 per cent. good, 40 per cent. fair, 20 per cent. bad. 22—Two-thirds good, one-third fair.

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Indiana—													
Terre Haute.....	chf	Cadillac	7-12	4	38	....	...	...	3,114	297	42.69	60.14	85.50
	chf	Overland	7-12	4	35	....	...	...	2,589	297	.....	49.10	85.50
	chf	Chevrolet	7-12	4	22	....	...	...	2,435	297	.....	32.50	85.50
	ch ho l	Oldsmobile	7-12	4	36	750	40	20	59	297	11.97	5.20	143.00
	ladd	Seagrave	7-12	4	73	....	...	283	38	297	4.10	25.97	143.00
	ho ch	Pierce-Arrow	1-3	6	48	900	35	20	24	297	.....	5.50	143.00
	ho ch	White	7-12	4	40	1,000	35	20	63	297	5.45	17.28	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	38	297	4.00	16.17	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	50	297	.....	18.94	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	57	297	.....	22.37	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	41	297	4.70	15.11	143.00
Vincennes.....	chf	Olds	6	4	40	....	...	...	....	....	72.00	187.27	127.54
	ch ho	Webb	6	6	70	900	36	74	123	45	419.00	15.60	.....
	ch ho	Buick	1	4	37	950	50	24	....	....	.....	.....	.....
Whiting.....	ch ho	Knox	5	4	50	1,200	36	70	123	45	419.00	15.60	.....
Iowa—													
Ames.....	ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	.....	.....	.....
Burlington.....	ch ho l	Am.-La France	3½	4	75	1,000	40	32	295	182	13.50	54.00	292.00
Cedar Falls.....	ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Cedar Rapids.....	chf	Chandler	2	..	40	0	1	0	228	315	0	.....	.....
	ch ho	Am.-La France	3	4	47	1,000	40	40	523	247	.....	.....	.....
	pp ch ho	Am.-La France	2	6	125	1,000	40	40	137	278	85.67	.....	.....
	ch ho	Am.-La France	1	..	47	1,000	40	40	550	220	.....	.....	.....
	ladd	Am.-La France	½	4	70	....	...	235	....	....	.....	.....	.....
Clinton.....	ch ho	Am.-La France	1	6	100	1,400	35	32	....	....	.....	.....	.....
Council Bluffs.....	chf	Marion	2	6	50	....	6	...	375	200	143.00	56.00	.....
	ch ho	Webb	4	4	74	1,000	40	32	283	150	500.00	30.00	300.00
	ch ho	Boyd	4	4	74	1,000	40	32	110	73	150.00	11.50	300.00
Davenport.....	chf	Marmon	2	6	40	0	24	0	725	319	0	43.50	.....
	ho	Ford (2)	1	4	...	450	6	32	80	40	0	.....	.....
	ho	Seagrave	3	6	80	1,000	6	...	210	107	.....	.....	.....
	ch	Ford	1	4	...	0	35	32	80	40	0	.....	.....
	ch ho l	Seagrave (4)	¼	6	80	1,200	6	32	90	45	0	.....	.....
	ladd	Seagrave	3	6	80	900	6	231	310	141	.....	.....	.....
	pp ho	Seagrave	¼	6	110	1,200	6	32	90	45	0	.....	.....
	tr	Seagrave	3	6	80	0	18	313	210	116	0	.....	.....
Des Moines.....	tr	Am.-La France	3	6	80	0	6	177	250	450	100.00	.....	.....
	ladd	Am.-La F. (4)	3	6	80	0	0	235	250	450	100.00	.....	.....
	ch ho l	Am.-La F. (6)	3	6	80	1,000	40	25	500e	100e	.....	.....	.....
	pp ho	Am.-La F. (3)	3	6	80	1,000	0	0	450	170	.....	.....	.....
	chf	Chalmers	3	6	50	....	...	...	1,500	999	.....	.....	.....
	ch ho l	Seagrave (4)	..	..	...	....	...	...	....	....	.....	.....	.....
Dubuque.....	chf	Saxon	..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho l	Am.-La France	2	4	70	1,000	70	32	....	....	.....	.....	.....
	pp ch ho	Robinson	2	..	...	1,000	...	...	....	....	.....	.....	.....
	pp ch ho	Am.-La France	2	6	100	1,000	40	32	....	....	.....	.....	.....
Ft. Dodge.....	ch ho l	Pope-Hartford	3½	4	48	1,200	40	36	112	86	77.20	54.52	.....
	ladd	Seagrave	1-3	6	79	....	...	307	....	....	.....	.....	.....
	pp ho	Seagrave	1-3	6	79	1,200	...	40	....	....	.....	.....	.....
Grinnell.....	ho ch	Am.-La France	3	4	58	1,400	45	40	59	27	0	3.75	.....
Iowa City.....	chf	Velie	4	4	45	....	5	...	....	82	20.00	30.00	.....
	ch ho	Seagrave	4	6	80	1,200	50	...	....	82	15.00	30.00	.....
Keokuk.....	pp ch ho	Am.-La France	1½	6	105	1,000	45	40	800	200	.....	.....	.....
LeMars.....	ch ho	Brockway	1	4	42	1,400	40	32	....	....	.....	.....	.....
Marshalltown.....	ch ho l	Kissel (2)	5	4	50	1,000e	53e	40e	....	....	.....	.....	.....
		Kissel	3	6	60	1,000	56	59	170	124	59.20	65.00	596.27
	ch la	Kissel	2	6	60	....	35	231	140	100	7.80	18.61	.....
	mot	Harley-Dav.	2	2	11	....	...	...	2,000	....	24.00	49.26	.....
Mason City.....	chf	Ford	..	..	...	....	45	...	....	83	.....	.....	.....
	ho	(1)	..	..	...	....	...	...	....	....	.....	.....	.....
	ae	To be delivered Feb. 15, 1917.											
Muscatine.....	sq		..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Am.-La France	3½	6	105	1,000	46	44	....	....	.....	.....	.....
	ch ho	Am.-La France	1-3	4	75	1,000	46	44	....	....	.....	.....	.....
	ch ho	Am.-La F. (2)	½	..	...	....	...	...	....	....	.....	.....	.....
Oskaloosa.....	ch ho	Am.-La France	4	4	72	1,200	40	34	210	104	16.03	21.70	376.00
Ottumwa.....	ch ho	White (2)	2	6	60	1,200e	23e	36e	30	13	10.00	57.00	.....
	ae	Seagrave	2	6	80	....	...	360	....	....	.....	.....	.....
Perry.....	ch ho	Am.-La France	2	6	100	1,400	40	32	....	....	.....	.....	.....
Sioux City.....	ch ho	Robinson	4	..	105	1,100	...	...	....	....	.....	.....	.....
	ch ho l	White (3)	4	..	60	1,100	...	...	....	....	.....	.....	.....
	ae	Am.-La France	1	6	105	....	6	177	....	....	.....	.....	.....
	ladd	White	3	..	60	....	...	...	....	....	.....	.....	.....
	pp ho	Am.-La France	1-3	6	105	1,200	6	32	....	....	.....	.....	.....
	pp ho	Am.-La France	o	..	75	1,100	...	...	....	....	.....	.....	.....
	chf	Haynes	o	..	55	....	...	...	....	....	.....	.....	.....
Washington.....	ch ho	Brockway	1	4	42	1,400	40	32	....	....	.....	.....	.....

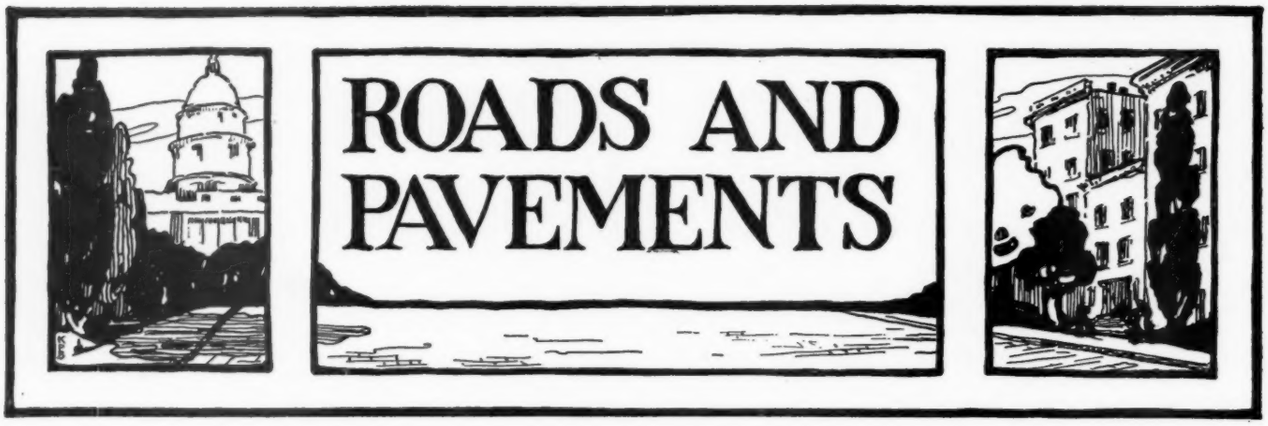
	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Waterloo	chf	Cadillac	3	4	34	....	...	...	....	....	.....	.....[17]	.....
	ladd	Am.-La France	2	6	100	....	...	235	....	....	.....	.....[18]	.....
	ch ho	Seagrave (2)	4	6	90	1,000e	40e	...	....	....	.....	.....[19]	.....
	ch ho	Dort (2)	2	4	36	1,000e	40e	...	....	....	.....	.....	.....
Kansas—													
Atchison	chf	Chalmers	1	6	40	....	6	...	900	115	12.24	50.56	190.00
	ch ho l	Webb, Thomas	5	6	79	1,500	40	34	164	96	150.64	29.16	370.00
	pp ho	Webb, Thomas	5	6	79	1,200	...	...	221	115	10.63	56.52	550.00
Chanute	chf	Hale	3	4	40	200	60	...	100	40	40.00	25.00	.....
	ho	Buick	1	4	37	1,150	6	50	75	40	10.00	25.00	.....
Ft.-Scott	ch ho	Am.-La France	1	4	70	1,000	40	40	75	73	.....	49.21[8]	306.05
	chf	Dodge	1	4	25	....	3	...	....	73	.....	.....	.....
Independence	chf	Kissel	4	4	50	150	70	...	190	70	0	.....	.....
	ho	Buick	1	4	35	1,000	6	38	150	60	0	.....	.....
	ch ho	South Bend	1	6	140	1,200	6	48	100	40	0	.....	.....
Kansas City	ch ho	Hale	..	..	...	....	...	...	....	....	.....	.....	.....
		Kissel)											
		Oakland)											
	chf	Chamlers)	3	6	40	....	...	...	....	....	.....	.....	.....
		Thomas)											
		Anderson)											
	ch ho	Robinson	6	6	90	1,000e	210a	180	2,412	....	20.70	876.00a	.....
	pp ho	Thomas	1	6	90	1,000	...	30	588	....	.....	.....	.....
	ladd	Kissel, Thomas	2	6	90	....	70	46	2,212	....	.....	.....	.....
Leavenworth	chf	Chandler	1	6	40	....	...	...	....	....	.....	.....	.....
	ch ho	Kissel	3	6	70	1,300	40	50	....	134	.....	.....	.....
	ch ho l	White	3	6	70	1,300	40	50	....	134	.....	.....	.....
	ladd	White	1	6	70	....	40	250	....	134	.....	.....	.....
Liberal	ch ho	Brockway	1	..	...	....	...	...	....	....	.....	.....	.....
Manhattan	ch ho l	White	3	6	60	1,200	40	28	....	32	.....	.....	.....
Newton	pp ch ho	Am.-La France	2	6	105	1,200	46	24	102	44	20.50	33.30	.....
Olathe	ch ho	Hale	..	..	...	....	...	...	....	....	.....	.....	.....
Parsons	chf	Kissel, Anderson	2	4	50	....	73	...	3,000	98	62.00	37.00	196.00
	ch ho l	Kissel, Anderson	1	4	60	1,000	35	36	360	31	20.00	30.00	609.00
	ch ho l	Kissel, Anderson	1	6	75	1,000	40	45	22	77	18.00	34.00	687.80
Pittsburg	chf	White	1½	4	200	41	...	...	....	....	.....	.....	.....
	ho	White	1	6	...	1,000	41	...	....	....	.....	.....	.....
Salina	chf	Mitchell	6	4	42	400	3	0	1,000	85	.....	.....	.....
	ch ho l	Anderson	5	6	49	1,100	46	44	400	85	.....	.....	.....
Topeko	chf	White	1	4	30	....	6	...	4,321	3	20.31	95.44	.....
	ch ho	Am.-La France	3	4	48	1,250	40	32	319	130	250.06	51.85	.....
	tr	Am.-La France	2	6	100	....	6	177	....	....	.....	.....	.....
	ch ho	Am.-La France	1	6	100	1,400	40	32	....	....	.....	.....	.....
	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	.....	.....	.....
	ladd	Speedwell	3	4	50	....	12	156	633	237	210.17	37.13	.....
Wichita	chf	Mitchell, Lewis	5	6	48	....	...	...	....	262	.....	.....	.....
	ho	Boyd	2	6	79	1,200	...	...	....	....	.....	.....	.....
	ch ho l	Webb	7	4	60	1,000	70	34	....	....	.....	.....	.....
	ch ho l	Seagrave	1	6	79	1,000	45	24	....	....	.....	.....	.....
	ae	Seagrave	4	..	79	....	...	85	....	....	.....	.....	.....
	ladd	Seagrave	2	6	79	....	...	50	....	....	.....	.....	.....
	pp ho	Webb	6	6	72	1,000	800	30	....	....	.....	.....	.....
	ch ho	Boyd	2	6	80	1,000	45	34	....	....	.....	.....	.....
	tr	Seagrave (2)	..	..	...	....	...	...	....	....	.....	.....	.....
Kentucky—													
Ashland	ch ho l	Seagrave	½	6	125	750	40	275	260	40	.....	.....	.....
	pp ch ho	Seagrave	½	6	125	1,500	40	34	240	....	.....	40.59	.....
Covington	tr	Am.-La France	2	4	70	....	...	...	....	....	.....	.....	.....
Frankfort	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	.....	.....	.....
Fulton	ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	.....	.....	.....
Hickman	ch ho	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
Hopkinsville		Has no motor apparatus at present.											
Lexington	chf	Jeffery	3	4	40	....	...	...	2,600	122	308.22	44.94	.....
	ae	Am.-La France	3	4	60	....	6	260	147	91	51.88	19.05	700.00
	ch ho l	Knox	5	4	50	800	35	36	325	216	126.07	30.46	400.00
	pp ch ho	Knox	5	6	100	1,200	36	36	161	104	120.05	32.38	820.00
Louisville	ae	Am.-La France	4	4	70	....	...	260	....	....	.....	.....	.....
	sal	Am.-La France	3	4	70	....	6	32	....	....	.....	.....	.....
	ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	.....	.....	.....
	chf	Jeffery	3	4	40	....	...	...	2,600	122	308.22	44.94	.....
	ladd	Am.-La F. (2)	1	4	70	....	...	235	....	....	.....	.....	.....
Mayfield	ch ho	Brockway	1	4	42	1,400	40	32	....	....	.....	.....	.....
Newport	ho		..	4	40	900	...	...	....	....	.....	.....	.....
	ladd		..	4	55	....	...	...	....	127	.....	70.00	.....
Paducah	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	.....	.....	.....
	ho ch	Jeffery (4)	..	4	29	....	...	...	....	....	.....	.....	.....
Louisiana—													
Baton Rouge	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	.....	.....	.....
Donaldsonville	ch ho	Am.-La France	½	6	55	1,400	40	32	....	....	.....	.....	.....
Hammond	ch ho	Am.-La France	1	4	70	1,400	35	32	....	....	.....	.....	.....
	ch la ho	Brockway	½	4	42	1,400	40	200	....	....	.....	.....	.....
Houma	pp ch ho	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
Monroe	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	.....	.....	.....
Morgan City	ch ho l	Am.-La France	2	6	38	1,200	40	24	300	46	140.00	25.00	.....
New Iberia	ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
New Orleans	pp ho	Am.-La France	2	6	200	1,200	6	32	....	....	.....	.....	.....
	ch ho	Am.-La France	2	6	55	1,400	40	32	....	....	.....	.....	.....
	tow	Am.-La France	2	6	100	....	...	...	....	....	.....	.....	.....
	ladd	Am.-La France	1	4	70	....	...	...	....	....	.....	.....	.....
	pp ho	Am.-La France	½	6	200	1,200	6	32	....	....	.....	.....	.....
Plaquemine	ch ho	Am.-La France	½	6	55	1,400	40	32	....	....	.....	.....	.....
Ruston	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	.....	.....	.....
Shreveport	chf	Hudson	2	4	60	....	...	...	....	....	.....	.....	.....
	ho	Reo	2½	4	30	1,000	...	...	....	89	.....	.....	.....
	ch ho l	Seagrave	6	4	52	1,200	50	36	....	251	.....	.....	.....
	ch ho l	Am.-La F. (2)	2	4	48	1,200	50	36	....	271	.....	.....	.....
	pp st	Am.-La France	4	6	90	....	...	...	....	70	.....	.....	.....
	pp ch	Am.-La F. (2)	4	4	48	1,200	40	36	....	91	.....	.....	.....
	pp ho	Am.-La France	1	6	135	1,500	0	23	....	180	.....	.....	.....
	tr	Martin	4	4	48	0	0	250	....	....	.....	.....	.....
W. Monroe	ch ho	Am.-La France	½	6	55	1,400	40	32	....	....	.....	.....	.....
Maine—													
Bath		Has no motor apparatus at present.							....	....	.....	.....	.....
Lewiston	ch ho l	Am.-La France	4	4	73	1,200	46	24	700	270	75.00	65.00	.....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Portland	ho ch	Am.-La France	o	..	...	2,000	70	...					
Rumford	ch ho	Am.-La France	3	6	100	1,400	40	32	....	....	.....	.....	.....
Skowhegan	ch ho	Knox	1½	4	5	1,000	80	41	300	40	3.00	43.50	.....
Maryland—													
Annapolis	ae	Am.-La France	1	4	70	....	...	...	....	....	.....	.....	.....
Arlington	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	.....	.....	.....
Baltimore	tr	Am.-La France	3	6	73	....	...	...	....	2,062	.....	.....	.....
	sal	Am.-La France	1	4	70	....	...	...	....	....	.....	.....	.....
	tr	Couple Gear	4	..	...	....	...	...	....	....	.....	.....	.....
	ho h p		1	..	...	....	...	...	....	....	.....	.....	.....
	tr	(7)	1	..	...	....	...	...	....	....	.....	.....	.....
	chf	(1)	1	..	...	....	...	...	....	....	.....	.....	.....
	ho	(17)	..	..	...	....	...	...	....	....	.....	.....	.....
	pp	(13)	..	..	...	....	...	...	....	....	.....	.....	.....
	pp ho	(1)	..	..	...	....	...	...	....	....	.....	.....	.....
	ae	(7)	..	..	...	....	...	...	....	....	.....	.....	.....
	sup	(2)	..	..	...	....	...	...	....	....	.....	.....	.....
	chf	(11)	..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	(1)	..	..	...	....	...	...	....	....	.....	.....	.....
	tr	(7)	½	..	...	....	...	...	....	....	.....	.....	.....
	ho	(3)	½	..	...	....	...	...	....	....	.....	.....	.....
	chf	(1)	½	..	..	...	....	...	...	....	....	.....	.....	.....
Cambridge	ch ho	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
Catonsville	pp	Am.-La France	5	..	...	....	...	...	....	....	.....	.....	.....
	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	.....	.....	.....
Crisfield	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Cumberland	ch ho l	G. M. C.	2-3	4	35	800	76	32	....	38	84.76	68.75	223.32
Govanstown	pp ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	.....	.....	.....
Hagerstown	ae	Am.-La France	3	4	75	....	6	177	....	....	.....	.....	.....
	pp ho	Am.-La France	1	6	38	1,200	40	32	....	....	.....	.....	.....
Salisbury	pp ho	Am.-La France	½	6	100	1,200	6	32	....	...	.....	.....	.....
Towson	pp ho	Am.-La F. (2)	3	6	38	1,200	40	32	....	....	.....	.....	.....
Massachusetts—													
Adams		Has no motor apparatus.											
Amherst	pp ch ho	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
Andover	pp ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	.....	.....	.....
	ch ho	Am.-La France	2	6	100	1,400	40	32	....	....	.....	.....	.....
Attleboro	ch ho	Knox	4	4	48	1,200	46	40	133	32	40.00	.....[3]	.....
	ch ho	Knox	5	4	48	1,200	46	40	647	111	75.00	.....[4]	.....
	ch ho	Federal	3	4	28	1,000	36	32	74	24	30.00	.....[5]	.....
	ch ho	Kelly-Springfield	..	4	30	1,000	56	40	....	....	.....	.....	new
	tr	Knox-Martin	3	4	40	....	56	190	135	60	12.00	.....[6]	.....
Belmont	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	.....	.....	.....
Beverly	chf	Willys-Over.	2	4	30	....	6	...	4,000	164	12.00	.....	364.00
	ch ho	Am.-La France	4	4	70	1,000	76	30	600	164	13.50	30.15	.....
	ch ho	White	2	6	...	1,000	76	30	600	164	13.50	30.15	.....
	tr	Knox-Martin	2	4	...	....	...	...	500	164	50.00	.....	.....
	pp st	Am. Brit.	4	..	...	....	...	...	15	13	0	30.00	.....
Boston	ch ho	Am.-La France	5	..	...	....	...	...	....	....	.....	.....	.....
	ladd	Am.-La F. (4)	4	4	70	....	...	235	....	....	.....	.....	.....
	ch ho	Am.-La F. (3)	4	4	70	1,400	35	32	....	....	.....	.....	.....
	pp ho	Am.-La F. (2)	3	6	100	1,200	6	32	....	....	.....	.....	.....
	ch ho	Am.-La F. (2)	3	4	70	1,400	35	32	....	....	.....	.....	.....
	tr	Am.-La F. (2)	3	6	100	....	6	177	....	....	.....	.....	.....
	ae	Am.-La France	3	6	100	....	6	182	....	....	.....	.....	.....
Brockton	chf	Pope	4	4	70	....	3	...	8,825	145	393.16	260.75	.....
	sq	Pope	1¼	4	50	700	48	40	377	231	127.51	53.84	.....
	ch ho l	Pope (6)	..	4	50	1,400	46	40	98	90	42.32	16.80	.....
	tr la	Pope (3)	..	4	50	....	6	...	95	65	82.65	17.50	.....
	tr st	A. & B.	2	4	40	....	...	...	98	75	.....	15.20	.....
Brookline	ladd	Am.-La France	3	4	70	....	...	235	....	....	.....	.....	.....
	pp ho	Am.-La F. (3)	3	6	100	1,200	6	32	....	....	.....	.....	.....
	tr	Am.-La France	1	6	73	....	...	...	....	....	.....	.....	.....
Chelsea	chf	Hudson	¼	..	76	300	35	...	800	534	0	.....	.....
	ch ho	Knox	4	..	50	1,000	70	50	1,000	534	.....	.....	.....
	ladd	Robinson	3	..	80	300	40	380	700	534	.....	.....	.....
	pp ch	Robinson	4	..	110	1,200	50	60	800	534	.....	.....	.....
Chicopee	chf	Stevens-Dur.	5	6	40	....	...	...	....	311	100.00	80.00	200.00
	sq	Stevens-Dur.	2	6	40	....	...	...	....	150	.....	.....	.....
	ch ho	Mack (2)	2	4	40	1,000	30	36	....	100	.....	.....	.....
	ch ho	Knox	2	4	40	1,000	30	36	....	100	.....	.....	.....
	ladd	Robinson	1	6	80	....	...	225	....	....	.....	.....	.....
	pp ch ho	Knox	5	4	90	1,000	...	36	....	100	.....	.....	.....
	pp ch ho	Robinson	1	6	110	1,000	...	36	....	100	.....	45.00a	.....
Clinton	pp	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Concord	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	.....	.....	.....
	ladd	Am.-La France	½	4	70	....	...	235	....	....	.....	.....	.....
Dedham		Has no motor apparatus at present.											
Easthampton	chf		..	..	...	2,000	...	...	....	50	.....	.....	.....
	ch ho	White	3	..	...	....	40	48	142	....	.....	.....	.....
	tr	Knox	..	..	...	....	...	224	....	....	.....	.....	.....
Everett	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	.....	.....	.....
Fall River	ae	Am.-La France	2	6	100	....	6	177	....	....	.....	.....	.....
	pp	Am.-La F. (3)	1	..	...	....	...	...	....	....	.....	.....	.....
	pp ho	Am.-La F. (2)	1	6	100	1,200	6	32	....	....	.....	.....	.....
	ch ho	Am.-La F. (4)	1	4	70	....	35	32	....	....	.....	.....	.....
	ae	Am.-La F. (2)	1	4	70	....	...	182	....	....	.....	.....	.....
	tr	Am.-La France	1	6	73	....	...	...	....	....	.....	.....	.....
	ch	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
	ladd	Am.-La France	1	4	70	....	...	235	....	....	.....	.....	.....
Fitchburg	ch ho l	Am.-La France	4	4	48	1,250	46	32	409	282	215.60	33.14	600.00
	ch ho l	Am.-La France	2	4	48	1,250	46	32	443	....[7]	15.00	36.04	.....
	chf	Cadillac	¾	8	31	0	6	0	....	....	.....	.....	.....
Franklin	ch ho	Comb. Lad. Co.	2	4	35	800	35	40	250	50	10.00	.....	.....
	pp	Water'us on Cad.	1	4	40	....	...	...	50	50	.....	.....	.....
Gardner	chf	Buick	..	4	40	....	...	...	150	....	.....	.....	.....
	ch ho	Knox (2)	..	4	50	1,000	40	48	210	76	475.00[8]	.....	400.00
	tr	Knox	..	4	40	....	...	...	50	23	407.00[8]	.....	700.00
Holyoke	tr	Am.-La F. (2)	3	6	73	....	...	...	....	....	.....	.....	.....
	ch ho	Am. La F. (2)	3	4	70	1,400	35	32	....	....	.....	.....	.....
Hopedale	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Hull	pp ho	Am.-La F. (2)	4	6	100	200	6	32	....	....	.....	.....	.....
Lawrence		No motor apparatus.											

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Lenox	ch ho	Am.-La France	5	..	...	....	...	...	....	....	.....	.....	.....
Lexington	ch ho	Am.-La France	5	4	70	1,400	35	32	....	....	.....	.....	.....
Lincoln	ch ho	Brockway	1	..	...	....	...	...	....	....	.....	.....	.....
Lowell	pp	Robinson	½	6	110	1,200	35	50	....	....	.....	.....	.....
	chf	Oakland (2)	5	4	30	....	6	...	....	....	.....	.....	.....
	chf	Buick	2	6	40	....	...	...	....	....	.....	.....	.....
	sal	Knox	6	4	40	200	...	20	519	263	.....	.....	.....
	ch ho	Knox	4	4	40	1,000	35	32	411	172	.....	.....	.....
	ch ho	Robinson	½	4	90	1,000	35	32	294	183	.....	.....	.....
	ch ho	Robinson (2)	½	4	90	1,000	35	50	....	....	.....	.....	.....
	ch ho	Seagrave	4	6	80	1,100	35	32	288	179	.....	.....	.....
Lynn	chf	Chalmers	6	..	...	....	...	...	....	....	.....	.....	.....
	chf	Pope-Hartford	2	..	...	....	...	...	....	....	.....	.....	.....
	chf	Buick	1	..	...	....	...	...	....	....	.....	.....	.....
	sq	Pope-Hartford	5	..	...	....	...	...	....	....	.....	.....	.....
	ho	Federal (6)	3	..	...	....	...	...	....	....	.....	.....	.....
	ch	Pope-Hartford	..	..	...	....	...	...	....	....	.....	.....	.....
	ch	Knox	..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Knox	3	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Seagrave	3	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Federal	3	..	...	....	...	...	....	....	.....	.....	.....
	ladd	(3)	3	..	...	....	...	...	....	....	.....	.....	.....
	ae		3	..	...	....	...	...	....	....	.....	.....	.....
	pp ho	Ahrens-Fox	3	..	...	....	...	...	....	....	.....	.....	.....
	tr st	A. & B. (5)	3	..	...	....	...	...	....	....	.....	.....	.....
	tr la	Knox-Mar. (4)	3	..	...	....	...	...	....	....	.....	.....	.....
Malden	chf	Knox	5	4	40	....	...	...	....	249	.....	.....	.....
	ch ho	Knox	..	4	60	950	35	...	864	....	.....	.....	.....
	ch ho	White	..	..	...	....	...	...	784	....	.....	.....	.....
	ch ho	Seagrave	1	6	90	1,000	40	...	....	....	.....	.....	.....
	ladd	Seagrave	1	6	90	....	...	325	163	....	.....	.....	.....
	ladd	Knox	7	..	...	....	...	...	....	....	.....	.....	.....
Marblehead	pp ho	Am.-La France	4	4	75	1,200	6	32	....	....	.....	.....	.....
	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	.....	.....	.....
	ch ho	Am.-La France	..	..	...	....	...	...	....	....	.....	.....	.....
Maynard	ch ho	Am.-La France	3	4	60	1,200	40	30	127	11	6.20	19.27	.....
Medford	ladd	Am.-La France	4	4	70	....	...	235	....	....	.....	.....	.....
Melrose	chf	Studebaker	3½	..	22	....	...	...	1,750	99	.....	.....	.....
	ch ho		5	..	...	800	120	...	200	....	.....	.....	.....
	ch ho	Studebaker	3	..	60	1,000	120	90	268	....	.....	.....	.....
	ladd		¾	..	80	....	...	298	183	....	.....	.....	.....
Milford	Has no motor apparatus at present.												
Milton	ch ho	Am.-La France	1	6	105	1,100	70	32	160	50	.....	.....	500.00
	ladd	Am.-La France	1	6	105	....	...	235	50	13	.....	.....	280.00
	pp ho	Am.-La France	½	6	105	1,200	40	250	20	4	.....	.....	400.00
New Bedford	chf	Locomobile	5	4	30	....	...	...	....	....	.....	.....	.....
	ho	Locomobile	1	..	...	....	...	...	....	....	.....	.....	.....
	ch ho	Locomo. (3)	..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho l	Locomobile	..	..	...	....	...	...	....	....	.....	.....	.....
	pp	Ahrens-Fox	..	..	...	....	...	...	....	....	.....	.....	.....
	pp	Robinson	..	..	...	....	...	...	....	....	.....	.....	.....
	pp	White	..	..	...	....	...	...	....	....	.....	.....	.....
	pp	Webb	..	..	...	....	...	...	....	....	.....	.....	.....
Newburyport	Has no motor apparatus at present.												
Newton	pp	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Norwood	chf	Ford	2	4	22	....	6	...	....	....	.....	.....	.....
	pp ch ho	Maxim	1	6	75	1,200	40	42	....	....	.....	.....	.....
Peabody	pp ch ho	Am.-La France	o	..	...	....	...	...	....	....	.....	.....	.....
	chf	Chandler	½	6	60	0	2	0	....	....	0	.....	.....
Pittsfield	ae	Am.-La France	4	4	75	....	6	177	....	....	.....	.....	.....
Quincy	chf	Kissel	o	6	45	....	...	...	....	....	.....	.....	.....
	ch ho	Am.-La France	6	4	60	1,200	40	30	....	....	153.85	60.75	.....
	ch ho	White	1	6	60	1,200	70	30	....	....	.75	60.26	.....
	ch ho	Kissel	3	6	60	1,200	70	30	....	....	65.00	27.50	.....
	tr st	A. & B.	2	4	60	....	...	...	....	....	142.75	11.35	.....
Randolph	ch ho	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
Revere	chf	Chalmers	¾	4	30	....	...	...	....	319	.....	.....	.....
	ch ho l	Am.-La France	7	4	50	500	70	25	....	319	.....	.....	.....
	ch ho l	Kissel	5	4	48	1,000	50	25	....	319	.....	.....	.....
Rockland	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	.....	.....	.....
Salem	chf	Buick	1	4	...	....	...	...	....	....	.....	.....	.....
	ch ho	Am.-La France	4	4	70	1,000	70	30	....	....	.....	.....	.....
	ladd	Robinson	1	4	...	....	35	350	....	....	.....	.....	.....
	pp ho	Robinson	2	6	...	1,000	...	20	....	....	.....	.....	.....
	pp ch ho	Robinson	2	6	...	1,000	35	20	....	....	.....	.....	.....
Somerville	ch ho	Am.-La France	4	6	100	1,400	40	32	....	....	.....	.....	.....
Spencer	No motor apparatus.												
Springfield	ae	Couple Gear (3)	6	..	120	....	...	...	....	....	.....	.....	.....
	ch ho	Couple Gear (2)	6	..	120	....	...	...	....	....	.....	.....	.....
	tr	Couple Gear	5	..	120	....	...	...	....	....	.....	.....	.....
Swampscott	ch ho	Am.-La France	5	..	...	....	...	...	....	....	.....	.....	.....
	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	.....	.....	.....
Taunton	No motor apparatus.												
Wakefield	chf	Buick	3	4	35	....	...	...	....	....	.....	.....	.....
	sq	Peerless	2	6	60	....	6	...	800	80	100.00	15.00	.....
	ho	Columbia (2)	7	14	40	....	30	24	100	40	50.00	5.00e	.....
	ch ho	Peerless	..	..	...	....	30	24	75	20	50.00	5.00	500.00
	ladd	Peerless	2	4	48	....	30	300	100	40	5.00	10.00	500.00
	pp ho ch	Webb	3	4	88	1,000	30	32	150	50	100.00	20.00	500.00
Waltham	chf	Rambler	5	4	40	....	...	...	1,597	160	131.00	157.06	300.00
	ch ho	Am.-La F. (2)	4	4	70	....	40	32	365a	119a	210.48	56.83a	771.00a
	ch ho	Am.-La France	3	4	70	....	140	52	202	112	197.00	32.27	636.00
	pp ho	Am.-La France	1	6	100	....	...	32	130	46	.....	75.88	1,079.00
Watertown	chf	Oldsmobile	1-3	8	40	....	6	...	735	41	0	47.78	310.00
	ch	Rambler-local	1-6	4	35	200	53	...	37	14	0	1.90	.....
	ch ho	Locomobile-local	4	4	45	1,200	76	36	681	79	0	62.66	480.00
	ladd	Maxim	1	6	66	200	46	312	629	114	0	65.25	480.00
Wellesley	ho	Gen. Motors	2-3	4	35	1,000	6	35	150	47	.....	18.75	300.00
	ch ho l	Seagrave	4	6	89	1,200	82	48	510	130	65.71	72.80	600.00
Winthrop	chf	Buick	3	4	25	....	6	...	....	160	80.00	.....	.....
Woburn	pp ch ho	Am.-La France	½	4	48	1,450	52	37	....	....	.....	.....	.....
	ladd	Am.-La F.	1-12	6	72	1,000	52	330	81	....	.....	.....	.....
	pp ho ch	Am.-La France	1	6	72	1,750	56	47	....	....	.....	.....	.....
	chf	Cadillac	1-12	4	30	150	25	0	....	....	.....	.....	.....
	ho	Winton	2	6	48	650	6	0	150	....	.....	.....	.....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Worcester	chf	Thomas	6	6	40	....	...	...	....	....	.....	.....	.....
	chf	Buick (4)	3	4	28	....	6	...	1,400	231	9.92	70.78	225.00
	ch ho	Am.-La F. (2)	3	4	70	1,400	35	32	....	....	.....	.....	.....
	ladd	Am.-La France	2	4	30	....	40	249	56	28	0.38	6.98	435.00
	pp ho	Am.-La F. (2)	2	6	100	800	6	32	213	70	0.80	36.45	1,200.00
	ch ho	Am.-La F. (2)	2	4	70	1,400	35	32	....	....	.....	.....	.....
	pp ho	Am.-La F. (2)	½	6	72	800	6	22	213	70	.....	.....	.....
	sq	Pope-Hartford	6	4	30	800	18	...	1,093	291	181.06	46.35	435.00
	ho	Netco (2)	..	..	40	800	6	30	....	....	.....	.....	.....
	ch ho l	Pope-Hart. (2)	..	..	...	....	...	...	....	....	.....	.....	.....
	ch ho l	Netco (2)	..	6	35	800	6	30	337	183	40.75	33.59	435.00
Michigan—													
Adrian	ch ho	Gramm-Bern.	o	4	50	1,600	40	26	....	....	.....	.....	.....
	pp ch ho	Am.-La F.	2½	6	100	1,200	40	36	325	75	23.00[9]	22.56	333.00
Albion	ch ho	Am.-La France	o	6	65	1,500	46	45	....	36	.....	.....	.....
Alpena	ch ho l	Studebaker	..	4	40	1,000	50	2	235	106	5.00	16.65	300.00
Ann Arbor	pp	Am.-La France	1	..	...	....	...	...	....	....	.....	.....	.....
	ladd	Am.-La France	1	4	70	....	...	235	....	....	.....	.....	.....
Battle Creek	chf	Jackson	5	4	50	....	3	...	....	165	27.00	.....	.....
	ch ho	Am.-La France	5	4	72	1,000	40	...	....	165	0	.....	.....
	ladd	Am.-La France	3	6	105	....	40	...	....	165	0	.....	.....
	pp ch ho	Am.-La F. (3)	4	6	105	1,000	40	46	....	165	0	.....	.....
Bay City	ladd	Am.-La France	3	4	70	....	...	235	....	....	.....	.....	.....
	ch ho	Am.-La F. (2)	2	6	100	1,200	6	32	....	....	.....	.....	.....
	pp ho	Am.-La France	1	6	93	1,350	4	36	....	....	.....	.....	.....
Benton Harbor	ch ho	White	2½	6	75	1,700	76	35	96	92	0	26.37	324.00
Cadillac	none												
Crystal Falls	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	.....	.....	.....
Dowagiac	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	.....	.....	.....
Flint	chf	Buick	6	4	36	....	...	...	....	....	.....	.....	.....
		Buick	1	6	56	....	...	...	3,047	275	.....	.....	.....
	ch ho	Am.-La France	5	..	...	....	...	...	....	....	.....	.....	.....
	pp ho	Am.-La F. (2)	4	6	72	1,000	6	32	400	118	.....	.....	.....
	ae	Am.-La France	4	4	48	....	6	332	....	66	.....	.....	.....
	pp ho	Am.-La France	2	4	48	1,000	40	32	742	275	.....	.....	.....
Grand Rapids	chf	Jackson	..	..	...	....	...	...	....	....	.....	.....	.....
	chf	Cartercar	5	4	25	....	...	...	4,000	621	3,000.00[10]	110.00a	116.80[11]
	sq	White	3	..	60	....	...	...	....	....	.....	.....	.....
	ladd	Couple Gear (3)	3	..	...	....	...	1,530e	300	....	.....	120.00e	.....
	tr st	Couple Gear	3	..	...	....	...	...	200	....	.....	75.00	.....
	tr st	Christie	3	..	...	....	...	...	200	....	.....	75.00	.....
	ae	Couple Gear	..	..	...	....	...	...	....	....	.....	.....	.....
	tr	Couple Gear (6)	..	..	...	....	...	...	....	....	.....	.....	.....
	ho	Various (12)	4	..	45	1,200e	...	...	350	....	.....	30.00e	.....
	ch	Olds (2)	5	..	45	250e	70e	40e	2,000	....	.....	75.00e	.....
	ladd	Various (2)	3	..	...	....	...	1,530a	300	....	.....	120.00e	.....
	pp	Seagrave	1	..	79	....	...	...	1,000	....	.....	50.00	.....
Hillsdale		Have no motor apparatus.											
Holland		Have no motor apparatus.											
Iron Mountain	ch ho	White	o	..	...	60	1,400	40	50	....	.....	.....	.....
Ironwood	pp ch ho	Am.-La France	3	6	105	1,100	40	40	300	106	66.00	.....	.....
Jackson	ch ho	Am.-La F. (2)	4	4	70	1,200	40	25	....	....	.....	.....	.....
	ladd	Am.-La France	3	4	70	....	40	235	....	....	.....	.....	.....
	chf	Jackson	4	4	50	30	3	...	....	....	.....	.....	.....
	pp ch ho	Seagrave (2)	..	..	...	1,000	40	25	....	....	.....	.....	.....
Lansing	ch ho	Olds	5	4	60	1,000	40	42	323	111	10.97	37.42	438.00
	ch ho	Olds	5	4	60	1,000	40	42	290	98	71.05	39.50	438.00
	pp	Robinson	4	6	110	1,000	...	36	154	69	74.58	63.91	1,095.00
Marquette	chf	Ford	2	4	22	....	...	...	3,000	77	0	.....	.....
Menominee	chf	Jeffery	1½	4	38	0	3	0	....	....	.....	.....	.....
Muskegon	chf	Saxon	½	3	...	....	...	...	....	....	.....	.....	.....
	ch ho	Am.-La F. (2)	1-12	6	100	1,400	40	32	....	....	.....	.....	.....
Petoskey	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	.....	.....	.....
Pontiac	chf	Ford	2	4	22	....	25	...	....	115	151.33	40.07	180.00
	ch ho	Am.-La France	5	4	75	1,200	40	36	....	91	150.59	20.63	540.00
	ch ho	Seagrave	2	4	80	1,500	50	36	....	72	13.50	2.89	360.00
Saginaw	chf	Hudson	3	6	32	....	...	...	....	....	.....	.....	.....
	ladd	Am.-La France	1	6	72	....	...	331	....	....	.....	.....	.....
	pp ho	Seagrave	2	6	102	....	...	30	....	....	.....	.....	.....
	ch ho	Seagrave	1	6	79	....	...	32	....	....	.....	.....	.....
	pp ho	Webb	5	6	72	....	...	32	....	....	.....	.....	.....
St. Joseph		None as yet. See list of prospective purchases.											
Traverse City	chf	Buick	½	6	45	200	40	...	2,000	24	0	12.00	190.00
Minnesota—													
Aurora	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Buhl	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	.....	.....	.....
Cloquet		Have no motor equipment at present.											
Detroit	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....
Duluth	ch ho	Am.-La France	5	4	70	1,000	40	28	150	43	191.82	23.40	457.32
	ch ho	Am.-La France	3	6	100	1,200	40	28	495	157	269.99	66.00	.....
	ae	Am.-La France	2	6	100	....	...	318	125	61	35.85	42.45	.....
	ladd	Am.-La France	1	6	100	....	40	251	450	156	28.95	48.90	.....
	chf	Kissel	1	6	40	....	...	...	....	....	385.00	212.78	.....
	ladd	White	½	6	70	....	40	261	70	20	.....	.....	.....
	pp ch ho	Am.-La France	2	6	100	1,200	40	28	320	106	52.81	63.43	.....
	pp ch ho	Am.-La France	2	6	100	1,200	40	28	287	108	27.80	70.80	.....
	ladd	Am.-La France	1	4	70	....	...	235	....	....	.....	.....	.....
Eveleth	ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	.....	.....	.....
Hibbing	chf	Velie	3	4	40	....	16	...	1,108	92	28.00	67.00	162.00
	pp ch ho	Waterous	¼	6	72	1,000	50	32	72	24	4.00	15.50	729.00
	ae	Am.-La F.	1-12	6	78	....	...	215	82	3	0	9.75	546.50
	ch ho	Kissel	3	6	60	1,000	60	32	212	92	103.00	31.72	364.50
Hutchinson	ch ho	Brockway	1	..	...	....	...	...	....	....	.....	.....	.....
Mankato	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	.....	.....	.....
Rochester	pp ho	Am-La France	4	6	100	1,200	6	32	....	....	.....	.....	.....
	ae	Am.-La France	½	4	70	....	...	177	....	....	.....	.....	.....
St. Cloud	ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	.....	.....	.....
S. St. Paul	pp ch ho	Waterous	..	4	70	1,200	40	...	....	....	.....	.....	.....
Stillwater		No motor-driven apparatus in department at pres.											
Virginia	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	.....	.....	.....
	ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	.....	.....	.....
W. Minneapolis	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	.....	.....	.....

(To be continued in the February Number.)



Canvas Belt Reduces Cost of Finishing Concrete Road

Frank F. Rogers, commissioner for the Michigan State Highway Department, tells of a considerable saving in the cost of finishing a concrete road by the use of a strip of 12-inch canvas belting which is drawn rigidly back and forth across the pavement, thereby producing a surface which in many respects is superior to that obtained by the old methods of hand-finishing.

The canvas strip is 12 inches wide and 3-ply. It is laid transversely across the pavement, projecting a little way beyond the forms on each end so that the workers can maintain a firm grip on it. After the surface has been struck off with the template, two laborers, one on each side of the road, drag the belting slowly back and forth, and gradually work it forward. They keep pace with the mixer by merely using the belt for a few minutes at intervals of from 20 to 30 minutes. The men using the template fall back and do this while the mixer is being moved forward. Thus the need of three finishers is eliminated, effecting a saving of close to $1.00 per hour.

It is said that this belt finishing process thoroly levels all ridges, does away with the wavy or corrugated surface left by the template, fills all hollows and secures as uniform a finish as could be desired. The smaller pebbles are worked down and firmly imbedded in place in the concrete and a gritty surface is produced without flushing excess water to the top or forming a film of neat cement on top. The uniformity is, however, the most noticeable result of the operation.

The road under construction is 18 feet wide and is being built according to the standard specifications of the Michigan State Highway Department which eliminate joints except at points where the work is stopped for more than 30 minutes. The stipulation is very favorable to the use of the belt for

finishing, inasmuch as it does away with the necessity for the frequent use of the bridge at joints and this can be satisfactorily accomplished only from a bridge.

By the omission of joints, some slabs over 150 feet in length have resulted. It is the belief of the department that if joints are omitted the cracks will form at approximately the same intervals at which joints are customarily placed and that such cracks can then be maintained in the same manner as joints. The early maintenance cost and the construction costs are thereby reduced to no small extent.

The idea of finishing by belt process originated in Wayne county, Michigan, only recently. After a thoro trial by the authorities there, it was suggested by them to the State Highway Commission and its first use by that department is on the road described in the foregoing.

Record Road Building in Ohio

With the $750,000 worth of contracts awarded December 21, covering some 38 miles of road improvement, the total of contracts awarded by the Ohio State Highway Department reaches 610 miles which will cost over $800,000.

Shoddy Paving in Chicago

Two investigations, more or less secret in their nature, were made of paving conditions in Chicago during the paving season of 1916. One of these covered the work under contract and the other the work done by the city forces.

In each case evidences of poor work were found. In the case of contract work this consisted of hastily constructed work, skimping of materials in mixtures and insufficient thickness of basis or tops. In that of city force work it consisted of lazy and careless employes, poor organization of forces, waste of materials and over-measurement of work done so as to make good showing of unit costs.

That both methods of doing work are equally poor, seems to indicate that the fault is in the general management of the city's improvement work, or in the inability of the management to control political employes or interfere when political contractors are found to be skimping their jobs.

All of these reasons have been assigned for the conditions found.

Itemized Cost of Concrete Paving

E. R. Conant, chief engineer of Savannah, Ga., has worked out the cost of constructing 31,503.06 square yards of concrete paving during 1916 in details of items, making a statement which will be of much interest and value to other engineers and to contractors. The cost of curbing is not included.

The conditions under which the work was done were as follows:

Proportions for Concrete: 1:1½:3; average thickness 6¼ inches; one-course pavement.

Price of material delivered on work:

Cement, approx., 1/3 at $1.63 per bbl.; 2/3 at $1.75 per bbl.

Crushed stone, approx., 1/3 at $2.64 per cu. yd.; 2/3 at $2.68 cu. yd.

Sand, approx., 1/3 at 70c per cu. yd.; 2/3 at 80c per cu. yd.

Tar paper expan. joints at 74 to 96 cents per roll.

Coal at $3.60 per ton.

Lumber at $20.00 per M.

Labor: White, gang consists of foreman at $4.00 per day, 20 men at $1.75 and 10 men at $1.50, 9 hours constitute a working day.

Hired Teams: One mule and cart combined is valued at $1.50 per day. Number used per day varied from 6 to 1.

Concrete Mixer: Batch type. (Austin cube No. 13).

The cost in cents per square yard for each item was as follows:

Labor—	
Watchman	1.654
Grading	8.678
Handling cement	0.615
Handling sand	2.675
Handling crushed stone	3.756
Spreading concrete	2.248
Operating mixer	3.908
Finishing surface	1.346
Making expansion joints	0.532
Covering pavement	0.688
Moving equipment	0.597
Cleaning up	2.014
Removing trees	0.222
Resetting curb	0.107
Total labor	29.040
Hired Teams—	
Grading	1.461
Moving equipment	0.122
Cleaning up	0.417
Covering pavement	0.062
Total teams	2.062
Materials—	
Cement	56.075
Sand	5.646
Crushed stone	39.216
Expansion joints (2-ply tar paper)	0.884
Coal	0.412
Tools and hardware	1.896
Lumber	0.290
Use of equipment	2.158
Total materials	106.577

Total cost of pavement per square yard, $1.37679.

The 31503.06 square yards of paving required 5459.48 cubic yards of concrete so that the cost of concrete per cubic yard was $7.95 in place.

The pavement is in one course. Savannah is south of the heavy frost line and there are never more than two or three days of freezing weather together so that there is no danger of pavements being heaved by frost.

The natural soil is most favorable for maintaining a good surface, being sand and lime, giving perfect drainage.

Concrete was thoroly well mixed at least one minute in the mixer for each batch.

Grade pegs were set for 6-foot squares, and the consistency of the concrete was such that only shovels were used for grading the concrete between the pegs.

When a sufficient length of concrete was laid the surface was rolled with a galvanized metal cylinder and a 1-inch rubber garden hose was dragged back and forth over the surface.

Joints were formed by using boiler-metal plates with tarred paper between, which were withdrawn after the next section had been carried far enough forward to hold the tar paper straight in place. The concrete was still fresh enough to fill the crevices left by the withdrawal of the steel plates. The paper stood 1 to 1½ inches above the surface. A split float was used on the joints which gave them beaded edges. The transverse joints were laid 35 feet apart and there were also joints along the curbs. The extra paper at the joints protects the edges of the concrete slabs until they receive practically their full strength before the traffic crushes the paper completely.

Pavements laid eight months ago show no signs of hair cracks or any other kind and the edges have not broken or chipped.

Motor Vehicles Carry Increased Traffic in Diminished Number of Vehicles

Among the most difficult problems presented to road builders and road planners is that of street traffic. The increase in the volume of this traffic has been almost sensational during recent years, especially since the use of the motor vehicle has become general. While this increase is quite obvious in all cities, the statistics of street traffic in London are unusually complete and the reports of the London Traffic Branch of the Board of Trade bring out some remarkable facts. The number of horse-drawn cabs licensed by the metropolitan police decreased from 11,404 in 1905 to 2,385 in 1912, while during the same period the number of motor cabs increased from 1 to 7,969. During the same period the motor omnibuses increased from 13 to 2,908, while the 3,623 horse-drawn omnibuses in 1903 have entirely disappeared. Some remarkable statistics are given as to the number of vehicles passing certain points at certain hours and during the day, but the surprising feature of these statistics is that the total number of vehicles licensed in 1913, including tramway cars, was actually 203 less than in 1903. No better illustration is afforded of the enormous increase in the service rendered by motor vehicles owing to their higher speed and greater flexibility.

Good Roads Notes

Nearly 400 miles was built under the postoffice appropriation bill of 1912 and about 170 miles in national reservations. Besides these constructions with national funds, the engineers of the U. S. Office of Public Roads and Engineering made recommendations as to improvement of roads in thirty-two counties after studies of the local conditions, inspected specific roads in 113 communities and assisted seven state departments having the road question in charge.

Of the $2,000,000 bond issue of Cook county, Ill., for good roads $800,000 will be spent in 1917. At the last meeting of the county board committee it was decided to improve the following roads: Higgins road, from the Mannheim road to the county line; Wheeling road, from Glencoe to Wheeling; Ninety-fifth street, from Western avenue to Keene avenue; Keene avenue, from Archer avenue to 119th street; Lake street, from the county line to the village of Melrose Park; 147th street, from Forty-eighth avenue to the village of Orland; Tinley Park road, from 147th street to Tinley Park; Irving Park boulevard, from the Wolfe road to the city limits of Chicago; Thornton to Lansfield road. The following roads will be improved with the aid of the state: Dempster street, from Evanston to Milwaukee avenue; Lincoln avenue, from the city limits northwest to Morton Grove. The work is to be started early in the summer.

Paving Done in 1916 and Proposed for 1917.

Yardage laid, cost and city's share for 1916. Yardage in prospect, estimated cost and city's share for 1917.

Data from City Engineers' Offices; obtained in December, 1916.

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Tot. Cost	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Alabama—							
Albany	.....	0	.....	.....	0	.....	.....
Florence	8,500	10[4]	.....	.....	B	.....	.....
Gadsden	15,000	0	0	0	18,341[2]	1.46[1]	0
Montgomery	45,000	.....	.....	.....	4,000	6,000	.....
Tuscaloosa	15,000	0	.....	.....	20,000	25,000	0
Arizona—							
Douglas	14,000	28,000	98,000	.....	80,000	175,000	.....
Phoenix	25,000	88,735	197,564	0	.....	.....	.....
Tucson	25,000	67,219	192,620	26,448	45,000	130,000	18,000
Arkansas—							
Ft. Smith	35,000	26,000	28,000	15,000	9,453	13,000	13,000
Hot Springs	20,000	4,000	14,000	12½%	25,000	.....	.....
California—							
Berkeley	65,000	69,660	117,800	.....	110,800	248,000	.....
Los Angeles	320,000	691,813	.....	.....	.....	.....	.....
Pasadena	44,000	35,035	26,524	.....	.....	.....	.....
Petaluma	8,000	4,000	4,550	.....	95,243	42,561	.....
Pomona	15,000	1,872	1,390	250	.....	.....	.....
Richmond	17,000	.....	.....	.....	250,000	.....	.....
San Bernardino	18,000	42,539	31,647	0	.....	.....	.....
San Diego	80,000	52,123	.....	0	.....	.....	0
San Francisco	420,000	472,251	931,980	83,134	500,000	1,000,000	.....
San Luis Obispo	8,000	10,000	11,000	11,000	30,000	35,000	25%
Santa Ana	12,000	104,598	55,831	0	.....	.....	.....
Santa Barbara	18,000	15,000	45,700	5,000	82,000	123,000	2,000
Santa Monica	9,000	82,368	154,000	.....	.....	.....	.....
Stockton	40,000	194,200	373,296	0	220,000	400,000	0
Colorado—							
Boulder	12,000	0	.....	.....	25,000	70,000	0
Colorado Springs	35,000	0	.....	.....	0	.....	.....
Ft. Collins	12,000	24,793	38,451	6,264	.....	.....	.....
Connecticut—							
Ansonia	18,000	4,850	.....	4,284	5,200	17,500	17,500
Danbury	25,000	16,000	17,000	.....	.....	.....	.....
Danielson	3,500	0	.....	.....	7,000	.....	.....
Derby	10,000	.....	.....	.....	1,800	4,500	2,000
Enfield	12,000	10,500	.....	all	.....	.....	.....
Greenwich	2,000	26,951	67,591	all	50,000	100,000	all
Hartford	120,000	.....	.....	.....	48,540	.....	.....
Manchester	18,000	2,727	4,066	4,066	3,400	3,000	3,000
New London	20,000	.....	.....	.....	6,300	19,000	.....
Putnam	8,000	6,000	5,000	5,000	1,000	.....	.....
Stamford	33,000	14,652	25,000	.....	.....	.....	.....
Wallingford	13,000	9,750	15,000	15,000	7,000	10,500	.....
Willimantic	13,000	0	5,000	.....	1,800	5,000	5,000
Winsted	9,000	9,801	15,474	all	7,000	11,000	all
District of Columbia—							
Washington	360,000	180,285	600,000	50%	200,000	700,000	50%
Florida—							
Gainesville	8,000	0	.....	.....	20,000	39,000	13,000
Pensacola	30,000	0	.....	.....	0	.....	.....
Georgia—							
Americus	11,950	20,000	26,000	7,000	15,000	18,750	4,750
Atlanta	184,000	187,835	279,657	52,649	100,000	200,000	50,000
Augusta	45,000	0	.....	.....	.....	.....	.....
Brunswick	12,500	7,500	.....	.....	.....	.....	.....
LaGrange	8,000	3,000	.....	.....	0	.....	.....

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Tot. Cost	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Cedar Falls	6,500	0	.....	.....	0	.....	.....
Cedar Rapids	45,000	42,259	69,154	.....	.....	.....	.....
Centerville	7,770	0	.....	.....	0	.....	.....
Charles City	8,000	0	.....	.....	20,000	.....	.....
Clinton	26,800	22,608	58,465	2,500	.....	.....	.....
Creston	7,500	67,350	128,415	0	4,000	7,000	.....
Davenport	48,154	109,425	218,425	21,206	100,000	.....	.....
Dubuque	43,000	30,635	64,721	.....	200,000	400,000	.....
Forest City	2,000	26,080	41,720	.....	.....	.....	.....
Ft. Dodge	23,000	65,000	130,000	15,000	.....	.....	.....
Ft. Madison	10,000	53,782	124,067	20,147	.....	.....	.....
Greenfield	1,500	24,978	43,300	.....	.....	.....	.....
Keokuk	16,000	36,696	42,074	87,992	.....	.....	.....
Knoxville	3,000	some	.....	.....	.....	.....	.....
Marshalltown	16,000	45,770	56,302	1,540	60,000	83,000	3,000
Mason City	20,000	164,700	338,386	.....	100,000	185,000	.....
Mt. Pleasant	4,000	some	.....	.....	.....	.....	.....
Muscatine	16,000	14,507	9,509	.....	0	.....	.....
Oelwein	7,200	32,000	60,705	4,800	7,500	13,000	0
Sioux City	62,000	297,000	453,705	175,000	250,000	.....	.....
Waterloo	34,000	23,910	53,500	0	50,000	100,000	0
Webster City	6,000	16,622	27,426	0	15,000	25,000	0
Kansas—							
Arkansas City	12,000	26,132	47,299	11,689	40,000	.....	A
Atchison	16,600	18,000	30,000	4,500	10,000	15,000	2,500
Chanute	10,000	3,500	5,161	1,500	2,500	3,700	1,200
Coffeyville	14,000	.....	.....	.....	4,000	.....	.....
Erie	1,500	25,000	53,000	.....	20,000	40,000	.....
Emporia	11,000	9,875	17,550	2,952	10,000	18,000	3,000
Hutchinson	20,000	.....	.....	.....	75,000	.....	.....
Independence	13,000	7,833	16,137	6,772	.....	.....	.....
Iola	11,000	34,000	42,840	.....	.....	.....	.....
Leavenworth	20,000	0	.....	.....	85,000	125,000	30,000
Manhattan	6,856	39,930	62,480	62,480	16,500	.....	16,500
Ottawa	9,127	18,718	46,265	11,648	7,600	17,000	1,500
Parsons	17,000	6,208	13,074	962	22,000	31,480	2,500
Pittsburg	19,000	70,197	119,950	A	60,000	.....	.....
Rosedale	10,000	15,000	15,000	.....	42,000	75,000	.....
Salina	15,000	47,461	79,000	¼	30,000	50,000	¼
Topeka	50,000	110,120	247,590	81,465	75 000	172,500	51,750
Wellington	7,000	80,005	150,556	73,524	13,000	25,000	10,000
Wichita	70,000	50,327	116,402	.....	75,000	.....	.....
Kentucky—							
Lexington	50,000	51,000	124,743	10,200	140,000	100,000	100,000
Louisville	265,000	160,480	414,838	119,980	196,000	450,000	190,000
Owensboro	18,000	60,000	18,000	18,000	70,000	115,000	14,000
Louisiana—							
Lake Charles	16,000	20,000	29,000	0	50,000	90,000	0
Shreveport	48,000	65,000	.....	.....	200,000	.....	.....
Maine—							
Lewiston	30,000	7,987	.....	.....	8,000	.....	.....
Portland	63,050	13,135	25,436	25,436	.....	.....	.....
Maryland—							
Baltimore	558,485	66,226	95,780	95,780	37,928	145,526	.....
Frederick	11,000	4,897	4,630	4,504	13,230	11,035	11,035
Havre de Grace	5,000	5,500	5,500	5,500	5,500	5,500	5,500
Massachusetts—							
Brookline	34,000	39,907	25,354	25,354	50,000	65,000	.....
Fitchburg	43,000	27,149	45,639	45,639	.....	70,000	.....

Savannah	75,000	51,184	87,000	32,000	.....	.....	.....
Waycross	15,000	35,236	5,721	1-3	43,000	17,000	1-3
Idaho—							
Boise	20,000	48,395	106,972	29,000	.....	.....	.....
Coeur d'Alene	8,000	0	.....	.....	8,000	.....	1-7
Lewiston	7,500	2,746	4,036	.....	3,830	5,745	.....
Pocatello	16,000	0	.....	.....	20,570	41,600	6,240
Illinois—							
Ardmore	1,600	.....	.....	.....	20,600	.....	.....
Aurora	36,000	26,000	57,660	9,640	25,000	55,000	8,250
Belleville	27,000	70,000	113,400	19,000	70,000	125,000	20,000
Berwyn	15,000	38,577	90,800	11,000	132,800	288,000	.....
Cairo	18,000	8,039	2,739	0	30,000	21,000	0
Canton	12,000	3,570	6,670	1,662	0	.....	.....
Champaign	17,223	30,000	111,521	900	90,000	253,000	.....
Chicago	2,521,822	2,536,000	6,860,000	300,000	2,000,000	6,000,000	.....
Chicago Heights	20,000	125,000	273,000	.....	55,000	.....	.....
Cicero	4,500	94,587	198,184	15%	94,000	200,000	15%
Danville	35,000	42,000	98,700	24,675	40,000	94,000	23,500
Decatur	45,000	85,561	230,000	.....	.....	.....	.....
DeKalb	9,000	17,595	38,632	10-25%	.....	.....	.....
E. St. Louis	85,000	29,300	.....	0	175,000	350,000	0
Flora	3,000	0	.....	.....	32,464	80,372	0
Freeport	22,000	19,144	35,800	10%	40,000	70,000	10%
Galesburg	24,514	17,760	47,645	3,266	75,000	206,250	12,375
Granite City	15,000	13,500	27,000	7,000	20,000	45,000	.....
Harvey	7,000	0	.....	.....	[1]	.....	.....
Hinsdale	5,000	5,952	11,343	.....	5,600	.....	.....
Joliet	36,000	141,551	317,015	19,020	77,865	152,687	9,161
La Grange	6,000	23,171	42,000	.....	170,000	200,000	.....
La Grange Park	2,500	32,000	12,280	.....	.....	.....	.....
Lincoln	12,164	0	0	0	22[2]	60,000	A
Lyons	2,500	.....	.....	.....	5,000	.....	.....
Madison	6,000	0	.....	.....	0	.....	.....
Mattoon	15,000	32,269	77,000	7%	32,000	80,000	7%
Moline	30,000	50,295	127,944	8,760	50,000	130,000	0
Morrison	2,000	44,000	100,000	25%	.....	.....	.....
Oak Park	31,400	187,185	490,300	.....	60,700	163,000	.....
Ottawa	10,000	14,100	35,082	0	8,500	175,000	.....
Pana	6,000	0	.....	.....	0	.....	.....
Paris	10,000	7,244	10,286	0	0	.....	.....
Peru	8,000	31,078	77,911	12%	.....	.....	.....
Rockford	55,000	159,491	275,456	92,387	.....	.....	.....
Rock Island	25,000	70,990	200,824	9,100	.....	.....	.....
Springfield	66,000	26,397	53,381	4,172	130,000	244,600	6,960
Sterling	10,000	11,640	28,788	5,757	36,735	90,000	.....
Streator	17,000	15,964	25,827	.....	17,000	.....	.....
Taylorville	7,912	0	0	0	0	0	0
Indiana—							
Anderson	30,000	30,290	43,979	0	10,000	.....	.....
Bedford	12,000	0	.....	.....	5,000	.....	.....
Brazil	10,000	7,834	9,825	1,413	7,470	11,205	.....
Connersville	10,000	38,041	55,955	6,823	.....	.....	.....
Crawfordsville	12,000	4,108	5,210	869	13,500	20,250	3,500
Elkhart	23,000	38,050	88,950	.....	33,500	.....	.....
Frankfort	9,500	19,540	49,720	4,734	.....	.....	.....
Goshen	10,000	38,714	78,610	16,403	40,000	82,000	18,000
Huntington	15,000	5,300	14,051	.....	10,000	.....	.....
Jeffersonville	10,000	0	.....	.....	0	.....	.....
Lafayette	21,000	2,660	.....	0	.....	.....	.....
La Porte	13,500	38,325	68,218	12,421	.....	.....	.....
Linton	10,000	0	.....	.....	0	.....	.....
Logansport	22,000	44,618	104,736	26,800	27,300	84,000	25,000
Madison	8,000	12,800	25,868	7,000	17,000	34,000	.....
Marion	25,000	2,130	6,788	C	20,000	40,000	A
Michigan City	22,000	25,871	45,098	12,225	45,000	.....	.....
Muncie	28,000	22,000	39,000	4,000	.....	.....	.....
New Castle	15,000	25,298	56,165	10,000	.....	.....	.....
Peru	15,000	0	.....	.....	0	.....	.....
Portland	6,600	.....	.....	C	.....	.....	.....
Richmond	25,000	29,120	51,452	11,912	8,000	14,000	3,000
Shelbyville	11,000	.....	.....	.....	.....	.....	.....
South Bend	67,500	74,782	150,846	26,877	77,183	154,155	.....
Terre Haute	70,000	2,286	1.53	A	47,830	92,500	17,500
Vincennes	18,000	107,506	193,777	36,587	100,000	225,000	31,000
Wabash	9,000	19,516	52,200	12,000	0	.....	.....
Iowa—							
Boone	14,000	0	.....	.....	60,000	.....	.....
Britt	1,440	36,234	83,994	.....	.....	.....	.....
Burlington	25,000	30,085	55,793	.....	.....	.....	.....
Greenfield	13,000	2,800	.....	.....	5,000	.....	.....
Lawrence	100,000	8,595	.....	all	.....	.....	.....
Lynn	100,000	64,920	88,470	all	60,000	81,300	all
Methuen	12,000	.....	.....	.....	22,000	2.50	2.50
Middleboro	9,000	3[4]	18,000	.....	12,000	.....	.....
New Bedford	114,000	113,795	.....	.....	.....	.....	.....
Newton	43,113	60,000	39,000	39,000	60,000	42,000	42,000
N. Adams	22,000	0	.....	.....	5,000	8,000	8,000
Norwood	12,000	34,000	66,170	52,195	45,000	45,000	26,500
Orange	5,500	0	.....	.....	0	.....	.....
Pittsfield	40,000	0	.....	.....	.....	.....	.....
Revere	28,000	19,170	30,000	30,000	40,000	100,000	100,000
Saugus	10,000	4,000	2,000	2,000	5,000	5,000	5,000
Southbridge	15,000	14,200	21,100	19,000	18,000	22,000	.....
Wakefield	13,000	5,000	6,250	2,250	10,000	12,000	8,000
Watertown	18,000	18,000	24,000	24,000	18,000	25,000	all
Webster	12,000	400	249	249	.....	.....	.....
Weymouth	14,000	1,948	2,077	2,077	5,000	8,000	8,000
Michigan—							
Albion	9,000	5,900	8,960	8,960	6,000	9,000	9,000
Alpena	12,000	4,409	6,300	6,300	.....	.....	.....
Ann Arbor	20,000	12,000	28,000	13,000	.....	.....	.....
Battle Creek	30,000	72,346	96,350	40.456	.....	.....	.....
Bay City	50,000	25,961	48,717	12,467	20,000	40,000	20,000
Benton Harbor	14,000	0	.....	.....	45,000	94,500	A
Boyne City	4,500	11,577	15,860	3,990	8,658	11,544	2,888
Cadillac	10,000	2,600	4,472	1,849	29,111	44,152	11,000
Coldwater	6,500	13,367	22,817	½	0	.....	.....
Detroit	820,778	976,173	2,399,220	.....	1,000,000	2,500,000	.....
Escanaba	15,000	0	.....	.....	40,000	52,000	10,400
Flint	80,000	108,000	245,400	60,000	150,000	340,000	80,000
Grand Haven	7,000	9,000	9,300	.....	15,000	32,000	0
Grand Rapids	140,000	108,035	237,953	.....	.....	.....	.....
Hillsdale	8,000	14,950	40,000	19,000	12,000	35,000	¾
Holland	12,000	9,500	20,415	5,000	14,000	25,000	8,000
Kalamazoo	50,000	46,866	76,600	16,180	40,000	75,000	26,000
Ludington	10,000	700	1,054	20%	40,000	30,000	20%
Manistee	12,000	0	.....	.....	2,656	0.80[1]	0.80[1]
Marquette	12,500	5,110	4,662	4,662	25,000	15,000	15,000
Monroe	10,000	2,910	5,789	2,689	.....	.....	.....
Muskegon	40,000	7,810	16,087	4,526	30,606	56,287	10,853
Minneapolis	301,000	392,897	900,000	30%	300,000	750,000	30%
Negaunee	6,800	13,900	14,996	14,996	13,000	.....	.....
Niles	5,500	0	.....	.....	.....	.....	.....
Owosso	10,000	5,720	12,592	5,036	7,000	15,540	6,216
Port Huron	20,000	7,620	13,860	5,000	8,000	.....	.....
Saginaw	60,000	6,980	17,500	5,800	24,000	70,000	25,000
Sault Ste Marie	13,500	5,874	18,085	6,028	.....	.....	.....
Ysilanti	10,000	37,056	57,115	.....	.....	.....	.....
Minnesota—							
Albert Lea	11,000	.....	.....	.....	.....	.....	.....
Austin	10,000	.....	.....	.....	.....	.....	.....
Bemidji	8,000	10,006	11,207	1-3	10,000	11,200	1-3
Chisholm	10,000	16,300	29,340	29,340	.....	.....	.....
Duluth	100,000	110,000	340,000	70,000	20,000	70,000	20,000
Eveleth	9,000	20,986	57,831	½ & A	.....	.....	.....
Hibbing	12,000	4,687	18,422	18,422	40,000	110,000	110,000
Mankato	15,000	9,339	12,327	467	.....	.....	.....
Rochester	10,000	50,366	88,810	10,000	.....	.....	.....
St. Cloud	15,000	33,226	81,500	0	25,000	57,500	0
Stillwater	10,970	5,797	8,945	4,865	7,000	17,500	2,500
Virginia	18,000	2,627	61,754	60%	18,000	55,000	60%
Mississippi—							
Greenwood	9,000	8,430	14,009	6,875	40,000	80,000	32,000
Laurel	14,840	50,000	88,400	.....	10,000	.....	.....
Vicksburg	25,000	48,902	161,563	.....	0	0	0
Missouri—							
Brookfield	8,000	1,000	1,320	.....	.....	.....	.....
Cape Girardeau	15,000	19,526	16,570	0	30,000	.....	0
Carthage	11,000	0	.....	.....	25,000	1.40	0
Columbia	12,600	19,917	26,913	692	6,009	12,310	200
Fulton	5,500	5,636	12,262	0	50,000	.....	.....
Independence	13,500	12,511	16,889	0	50,000	80,000	0
Jefferson City	16,000	25,500	40,900	0	.....	.....	.....
Kirksville	9,000	3,280	5,000	0	15,000	32,000	0
Moberly	15,000	1,040	1,612	0	8,000	12,000	0
Poplar Bluff	12,000	6,000	9,000	0	20,000	30,000	0
St. Louis	800,000	452,700	1,061,000	80,000	600,000	1,400,000	50,000
Sedalia	20,000	19,807	28,570	0	34,000	46,000	0
Springfield	45,000	66,314	72,214	15,132	45,000	67,500	.....

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Tot. Cost	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Montana—							
Anaconda	16,000	75,511	161,145	0	50,000	110,000	0
Billings	14,000	35,893	99,439	0	20,500	55,000	0
Butte	100,000	22,586	79,337	.....	29,000	.....	.....
Great Falls	30,000	29,066	53,110	.....	.....	.....	.....
Helena	18,000	4,500	10,400	.....	23,400	41,000	14,000
Livingston	6,000	5,379	14,396	.....	0	.....	.....
Nebraska—							
Beatrice	10,000	36,100	85,000	20,000	40,000	95,000	22,500
Columbus	6,000	0	.....	.....	54,000	110,000	28,695
Fairbury	6,000	0	.....	.....	50,000	.....	.....
Fremont	11,000	66,231	104,278	26,126	30,000	.....	.....
Hastings	15,000	84,989	170,000	.....	129,000	1.75	.....
Lincoln	55,000	139,937	296,500	0	.....	.....	.....
Nebraska City	6,000	0	.....	.....	20,000	40,000	10,000
Norfolk	10,000	100,000	180,000	40,000	50,000	75,000	.....
New Hampshire—							
Laconia	13,000	.....	.....	.....	10,000	.....	.....
Portsmouth	12,000	0	0	0	14,000	45,000	45,000
New Jersey—							
Bayonne	65,000	99,000	175,000	15,000	90,000	180,000	16,000
Bloomfield	20,000	30,000	75,000	.....	50,000	125,000	.....
E. Orange	42,000	16,401	41,408	.....	.....	.....	.....
Elizabeth	85,000	72,000	208,000	75,000	80,000	220,000	85,000
Harrison	15,000	18,512	33,970	25,021	20,000	42,000	.....
Irvington	23,000	10,918	22,829	.....	24,940	58,000	.....
Jersey City	313,500	147,047	292,901	261,314	74,800	145,860	100,000
Montclair	26,000	68,300	188,600	½	190,000	470,000	½
New Brunswick	31,000	100,905	256,967	25%	.....	.....	.....
Passaic	70,000	29,773	53,825	13,500	44,000	71,000	25,000
Ridgewood	7,000	48,430	50,000	38,000	30,000	25,000	25,000
S. Amboy	10,000	0	.....	.....	20,000	.....	.....
Summit	10,000	.....	.....	.....	7,900	.....	.....
Trenton	105,000	80,000	.....	.....	64,000	.....	.....
Union	22,000	30,000	45,000	.....	15,000	25,000	.....
W. Orange	17,000	8,200	.....	.....	17,500	.....	.....
Nex Mexico—							
Roswell	8,000	7,337	14,179	.....	1,160	28,500	.....
New York—							
Albany	110,000	150,924	312,512	100,000	114,000	250,000	80,000
Albion	6,100	2,600	11,000	11,000	28,850	102,000	80,000
Amsterdam	36,000	7,510	27,900	13,950	45,000	130,000	65,000
Auburn	37,000	7,000	.....	.....	16,000	40,000	27,500
Batavia	14,000	20,000	61,000	1-3 & A	10,000	30,000	1-3 & A
Binghamton	56,000	18,322	39,804	½	.....	.....	.....
Buffalo	480,000	267,446	916,730	183,460	270,000	920,000	185,000
Cohoes	25,000	13,897	45,434	36,756	11,000	40,000	35,000
Elmira	45,000	38,916	81,437	.....	32,000	.....	.....
Fredonia	5,000	0	.....	.....	4,200	2.85[1]	1-3
Fulton	12,000	115,000	8,500	3,500	10,500	20,000	8,000
Geneva	15,000	32,250	.....	1-3	21,000	75,000	1-3
Gloversville	21,000	14,450	25,210	¼	.....	.....	.....
Hudson	13,500	35,000	45,000	30,000	.....	.....	100%
Hudson Falls	6,000	1,700	4,725	2-3	.....	.....	.....
Ithaca	20,000	3,881	7,716	1-3 & A	4,400	13,200	1-3 & A
Jamestown	38,000	19,947	48,418	3,360	.....	.....	.....
Johnstown	12,000	510	1,020	340	20,000	30,000	10,000
Kingston	26,000	42,062	35,332	35,332	.....	.....	.....
Little Falls	13,000	14,112	37,470	18,735	.....	.....	.....
Lockport	20,000	8,500	20,000	1-3	9,000	22,000	.....
Mamaroneck	7,290	4,154	11,216	.....	.....	.....	.....
Middletown	17,000	6,200	17,324	5,800	.....	.....	.....
New Rochelle	34,500	95,486	162,227	162,227	.....	.....	.....
Niagara Falls	48,000	22,715	94,000	10,000	50,000	200,000	15,000
N. Tonawanda	13,600	1,384	2,453	.....	16,000	.....	.....
Norwich	8,500	3,360	8,514	1-3	.....	.....	.....
Olean	20,000	1,770	4,424	170	23,600	.....	.....
Oneida	9,800	4,874	15,729	5,243	6,000	22,880	7,627
Ossining	14,000	D	.....	1,100	.....	.....	.....
Oswego	25,000	7,259	30,351	10,000	7,000	29,000	9,500
Plattsburg	12,000	0	0	.....	3,600	8,000	5,000

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Sq. Yds.	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Pennsylvania—							
Allentown	65,000	46,860	91,550	19,200	.....	.....	.....
Bethlehem	16,000	37,738	53,441	17,814	.....	.....	.....
Blakley[3]	7,000	.....	.....	.....	50,000	2.60[1]	1-3
Bloomsburg	8,000	0	.....	.....	6,000	.....	.....
Bradford	15,000	4,799	22,962	4,150	23,700	80,000	.....
Butler	26,000	2,948	.....	1-3	.....	.....	.....
Carbondale	19,000	40,000	.....	.....	38,500	.....	1-3
Carlisle	11,000	.....	.....	.....	12,000	21,000	1-3
Chester	60,000	40,000	90,000	20,000	.....	.....	.....
Coatesville	20,000	.....	.....	.....	1,000	.....	.....
Connellsville	15,000	24,815	51,580	1,560	29,230	64,854	.....
Dickson City	9,000	See Blakley.					
Du Bois	14,000	4,144	.....	all	10,000	.....	all
Duquesne	15,727	2,475	7,526	0	.....	.....	.....
Erie	80,000	32,929	55,396	5,925	75,000	13,500	5,000
Farrell	14,000	14,700	23,373	.....	15,000	.....	.....
Franklin	10,000	0	.....	.....	13,000	27,000	5,000
Freeland	8,000	2,000	1,200	1,200	10,000	5,600	.....
Greensburg	15,000	10,218	22,405	7,468	11,300	.....	.....
Greenville	8,500	0	.....	.....	8,700	.....	.....
Hanover	10,000	.....	.....	.....	20,000	45,000	15,000
Harrisburg	64,000	30,700	52,000	.....	4,000	8,000	.....
Hazleton	30,000	16,064	18,125	18,125	17,000	30,900	1-3
Homestead	21,000	1,100	2,560	2,560	.....	.....	.....
Jermyn	7,000	See Blakley.					
Jessup	7,000	See Blakley.					
Johnstown	68,000	8,939	16,919	6,970	.....	.....	.....
Juniata	6,500	11,716	22,131	7,377	15,000	25,000	1-3 A
Lebanon	21,000	31,000	89,000	16,000	30,000	90,000	8,125
Monongahela	12,500	2,370	5,375	2,576	4,700	10,000	20,000
Norristown	32,000	11,400	25,650	7,500	10,000	25,000	2,500
N. Braddock	15,345	6,665	13,332	4,444	10,000	22,000	7,000
Northampton	10,500	11,394	.....	all	10,700	.....	7,333
Oil City	20,000	728	3,168	1,181	1,000	.....	all
Olyphant	10,000	See Blakley.					
Pittsburgh	625,000	171,064	438,700	.....	.....	.....	.....
Pittston	20,100	6,670	19,312	6,437	12,000	39,960	13,320
Rankin	7,500	5,800	17,000	1-3	12,000	30,000	1-3
Reading	115,000	63,236	118,435	103,000	.....	.....	.....
S. Bethlehem	19,973	15,812	9,788	all	.....	.....	.....
Steelton	.....	.....	.....	.....	.....	150,000	all
Throop	8,000	See Blakley.			.....	150,000	1-3
Titusville	9,000	0	.....	.....	9,000	16,000	16,000
Waynesboro	10,000	7,292	3,499	2,476	15,000	10,500	7,500
Wilkes-Barre	75,000	42,736	113,458	A	50,000	135,000	A
York	50,000	14,888	27,543	.....	15,300	.....	.....
Rhode Island—							
Pawtucket	52,000	22,465	.....	.....	.....	.....	.....
Woonsocket	44,000	30,500	93,013	.....	30,000	.....	.....
South Carolina—							
Charleston	35,340	52,000	.....	.....	.....	.....	.....
Columbia	50,000	12,725	16,025	.....	13,000	.....	.....
Florence	10,000	12,936	18,551	18,551	14,000	21,000	21,000
Greenville	35,000	90,000	215,000	110,000	65,000	130,000	65,000
Greenwood	8,000	80,000	156,000	½	6,000	7,500	½
South Dakota—							
Aberdeen	14,000	0	.....	.....	5,000	.....	.....
Lead	8,125	1,597	5,082	2,127	2,020	6,599	3,737
Mitchell	8,000	31,257	68,604	.....	27,480	.....	.....
Sioux Falls	23,000	157,943	295,433	0	65,000	120,000	0
Watertown	9,000	375	559	0	.....	.....	.....
Tennessee—							
Chattanooga	80,000	84,078	183,300	79,140	24,120	51,000	20,000
Jackson	16,000	22,791	46,721	1-3	28,000	57,400	1-3
Memphis	135,000	12,850	29,710	½	.....	.....	.....
Texas—							
Amarillo	18,000	68,297	124,270	40,000	10,000	18,000	6,000
Austin	36,000	58,932	121,779	60,823	50,000	100,000	45,000
Cleburne	16,000	0	.....	.....	50,000	87,500	0
Dallas	135,000	160,850	375,488	60,000	868,127	1,965,837	200,000

Port Jervis	10,000	5,586	.....	6,000	.....	.....	.....
Poughkeepsie	32,000	26,300	71,000	.....	.....	.....	.....
Salamanca	10,000	47,317	140,000	38,960	40,000	120,000	40,000
Utica	87,000	38,256	116,880	38,960	40,000	120,000	40,000
Watertown	28,000	9,581	32,784	16,392	25,000	35,000	½
Watervliet	17,000	0	0	0	.....	350,000	1-3
North Carolina—							
Asheville	20,000	58,771	90,648	.....	.....	.....	.....
Charlotte	50,000	70,000	91,450	.....	10,000	15,000	3,500
Durham	28,000	10,000	23,800	3,800	.....	.....	.....
Fayetteville	10,000	32,890	21,000	7,000	0	.....	.....
Greensboro	23,000	27,100	32,078	17,100	15,000	18,000	9,500
Raleigh	25,000	150,000	242,400	52%	100,000	161,000	½
Wilmington	35,000	1,400	1,750	1,750	7,500	15,000	15,000
North Dakota—							
Bismarck	7,000	25,000	66,000	20%	170,000	370,000	20%
Fargo	22,000	35,712	106,240	109,907	100,268	300,000	20%
Grand Forks	13,500	9,739	27,007	.....	10,000	.....	.....
Mandan	5,000	51,088	180,180	0	.....	.....	.....
Ohio—							
Ashtabula	25,000	11,616	33,828	4,296	2,100	13,900	278
Barberton	15,000	7,400	16,050	.....	.....	.....	.....
Bellefontaine	9,000	6,000	16,300	.....	.....	.....	.....
Bowling Green	6,000	7,825	11,400	429	20,000	30,000	2% & A
Cambridge	15,000	8,954	20,986	7,731	23,225	74,765	16,329
Canton	73,000	66,160	176,728	41,693	155,853	533,635	163,300
Chicago Junction	3,600	11,320	19,340	2%	8,300	16,000	.....
Cincinnati	485,444	89,320	384,491	279,596	.....	.....	.....
Circleville	8,000	10,952	20,062	3,384	12,000	1.86[1]	.....
Cleveland	750,000	297,214	.....	.....	.....	.....	.....
Conneaut	9,000	14,924	31,320	5,406	23,000	60,000	9,000
Coshocton	12,000	10,787	16,997	3,400	.....	.....	.....
Delaware	10,000	12,000	21,600	2%	3,000	5,400	2%
E. Cleveland	20,000	45,332	115,794	79,992	18,666	63,000	48,600
E. Liverpool	25,000	12,548	38,863	32,818	43,380	157,096	76,324
Findlay	20,000	38,480	7,968	19,355	32,685	64,629	14,995
Fostoria	12,000	2,638	4,273	1,500	5,000	14,280	2,000
Galion	8,175	18,334	45,521	11,380	13,000	.....	¼
Ironton	15,000	33,355	47,080	11,216	.....	.....	.....
Jackson	6,500	0	.....	.....	3,000	5,000	2% & A
Lakewood	31,000	40,135	100,518	2% & A	.....	.....	.....
Lancaster	13,000	20,936	26,110	5,770	17,499	24,123	6,021
Lorain	36,000	10,300	33,110	.....	50,000	.....	.....
Marion	30,000	32,921	112,227	5,500	40,000	145,000	7,250
Massillon	18,000	12,173	17,406	8,868	.....	.....	.....
Norwalk	8,000	11,000	26,000	1-3	9,000	20,000	.....
Oak Hill	1,500	0	.....	.....	11,497	23,008	5% & A
Piqua	15,000	59,488	165,695	25,000	.....	.....	.....
Ravenna	6,500	6,400	15,000	7,000	12,000	25,000	14,000
Tiffin	14,200	16,800	36,507	3,500	15,000	.....	2% & A
Toledo	215,000	169,368	.....	.....	.....	.....	.....
Urbana	10,000	34,000	81,000	2% & A	.....	.....	.....
Van Wert	8,500	25,136	64,279	.....	0	.....	.....
Warren	22,000	41,478	117,000	28,900	70,230	287,400	24,900
Washington C. H.	8,000	46,585	104,246	49,041	26,000	.....	.....
Wooster	8,000	7,184	14,994	.....	20,000	45,000	.....
Xenia	12,000	29,000	91,000	.....	33,000	.....	.....
Youngstown	80,000	57,949	111,409	.....	.....	.....	.....
Zanesville	30,000	29,500	53,375	22,747	47,438	105,057	35,768
Oklahoma—							
Durant	8,000	15,730	28,700	0	32,000	60,000	0
Enid	18,000	0	.....	.....	500	.....	.....
New Wilson	3,000	0	.....	.....	15,500	28,000	0
Sapulpa	17,000	26,731	58,838	0	36,000	.....	0
Shawnee	18,000	0	.....	.....	30,000	67,000	0
Oregon—							
Astoria	17,000	49,558	100,000	.....	47,000	.....	.....
Portland	250,000	206,124	398,723	.....	110,260	260,000	.....
Salem	16,000	16,395	17,757	.....	40,000	.....	.....
Denison	30,000	25,828	28,674	7,168	.....	.....	.....
Greenville	10,000	550	622	622	.....	.....	.....
Houston	125,000	259,969	423,925	145,705	40,000	90,000	40,000
Paris	15,000	24,110	59,729	28,301	.....	.....	.....
Port Arthur	20,000	0	.....	.....	60,000	140,000	1-3
San Antonio	130,000	245,900	550,000	248,000	60,000	140,000	60,000
Texarkana	20,000	2,470	5,367	.....	.....	.....	.....
Waxahachie	10,150	20,000	28,500	7,000	200,000[7]	300,000	¼
Wichita Falls	16,000	29,000	36,000	12,000	30,000	37,500	12,500
Utah—							
Ogden	32,000	35,786	81,481	.....	.....	.....	.....
Provo	10,000	7,042	8,077	761	.....	.....	.....
Vermont—							
Montpelier	8,000	4,478	.....	4,478	9,000	14,000	.....
Rutland	15,000	2,029	8,300	5,300	.....	.....	.....
Virginia—							
Clifton Forge	6,000	3,000	2,400	2,400	5,000	5,000	5,000
Danville	28,000	8,000	8,500	8,500	.....	.....	.....
Newport News	20,000	.....	.....	.....	.....	.....	.....
Norfolk	89,612	12,375	.....	96,956	.....	.....	.....
Staunton	12,000	5,000	14,700	14,700	.....	.....	.....
Suffolk	15,000	9,200	9,844	9,844	5,000	5,350	5,350
Washington—							
Aberdeen	18,000	21,490	44,441	.....	.....	.....	.....
Bellingham	30,000	114,600	243,700	0	.....	.....	.....
Centralia	10,000	8,214	9,539	300	20,000	24,000	0
Everett	25,000	15,213	31,438	0	15,000	30,000	0
Olympia	10,000	4,205	11,500	.....	.....	.....	.....
Seattle	348,600	319,576	765,014	6,580	282,500	680,000	10,000
Spokane	140,000	55,206	117,708	7,762	10,000	17,000	.....
Tacoma	104,800	3,409	8,147	0	.....	.....	.....
Vancouver	10,000	3,900	6,740	0	0	.....	.....
Walla Walla	20,000	116,607	102,827	668	.....	.....	.....
West Virginia—							
Bluefield	18,000	4,926	7,397	1-3	8,000	12,000	1-3
Charleston	30,000	121,884	286,744	.....	.....	.....	.....
Fairmont	16,000	20,100	16,900	1-3 & A	.....	.....	.....
Martinsburg	14,500	0	.....	1-3	200,000	250,000	1-3
Moundsville	12,000	5,096	6,735	2,600	14,000	18,000	75,000
Parkersburg	30,000	42,957	74,000	16,300	60,357	95,900	5,380
Wisconsin—							
Appleton	18,000	13,095	34,636	11,567	7,000	16,800	5,500
Baraboo	7,000	9,000	11,500	6,000	6,000	9,000	4,500
Beloit	20,000	72,437	117,895	18,980	0	.....	.....
Chippewa Falls	1,000	.....	.....	.....	5,000	12,500	1-3
Eau Claire	20,000	16,168	27,473	.....	40,000	.....	.....
Fond du Lac	20,000	24,285	47,137	7,902	47,000	90,000	20,000
Grand Rapids	7,500	13,983	23,673	8,209	11,300	22,308	8,769
Green Bay	30,000	0	.....	.....	22,000	.....	.....
Janesville	14,000	14,388	16,972	.....	46,000[9]	.....	.....
La Crosse	32,000	3,522	6,838	4,181	.....	.....	.....
Madison	32,000	49,168	109,565	20,000	50,000	112,000	20,000
Marshfield	6,000	33,954	62,970	.....	.....	.....	.....
Menasha	7,000	13,000	24,000	14,000	15,000	26,000	.....
Menomonee	5,036	10,168	14,080	14,079	.....	.....	.....
Oshkosh	35,000	13,546	31,150	1,170	50,000	80,000	20,000
Portage	6,000	0	.....	.....	35,000	60,000	¼
Racine	47,500	66,796	159,204	34,775	88,048	209,113	55,965
Superior	50,000	27,366	49,065	0	50,000	80,000	0
Waukesha	10,500	11,013	10,132	3,594	.....	.....	.....
Wausau	19,000	16,226	28,433	14,216	18,000	30,000	15,000
West Allis	12,000	46,300	92,530	22,113	50,000	.....	.....
Wyoming—							
Cheyenne	0	.....	.....	.....	10,000	20,000	20,000
Rock Springs	6,000	0	0	0	.....	.....	.....

A, intersections of streets; B, business part of city; C, additional pavement laid by township within city limits; D, repair work; G, gravel; O & S, oil and screenings; S. O., Standard oil; T, Topeka mixture.

Absence of any entry in the columns of work "Proposed for 1917" indicates that no plans have yet been made for 1917. (1) indicates cost of grading is included; (2) cost of curb or curb and gutter; (3) cost of drainage inlets; (4) cost of drains or sewers. If none of these four symbols appear the cost figures given include them all.

[1] Per square yard.
[2] Contract awarded.
[3] Linear feet.
[4] Miles.
[5] Blocks of street.
[6] Includes boros of Blakley, Dickson City, Jermyn, Jessup, Olyphant, Throop.
[7] Will lay considerable in 1917.
[8] Old brick or macadam foundation.
[9] Kind not yet decided.

(To be continued in the February Number.)

MISCELLANEOUS

Meetings of Organizations

January 17-18 at the society house, New York. American Society of Civil Engineers. Charles Warren Hunt, secretary.

January 18-19 at Washington, D. C. American Forestry Association. P. S. Risdale, secretary, 1410 H street, N. W., Washington, D. C.

January 18-20 at Purdue University, Lafayette, Ind. Indiana Engineering Society. Charles [illegible]ossmann, secretary, Merchants Bank building, Indianapolis, Ind.

January 19 at New York. American Society of Engineering Constructors. J. R. Weinburger, secretary, S. Ferry building, New York.

January 20 at Kansas City, Mo. Western Paving Brick Manufacturers' Association. G. W. Thurston, secretary, 416 Dwight building, Kansas City, Mo.

January 22-23 at Hotel Astor, New York. The National Civic Federation. V Evert Macy, president, Metropolitan Tower, New York.

January 23-25 at New York. American Wood Preservers' Association. F. J. Angier, B. & O. R. R., Baltimore, Md., secretary.

January 31-February 1-2 at Washington, D. C. Annual meeting of the Chamber of Commerce of the United States.

February 5-9 in Mechanics building, Boston, Mass. American Road Builders' Association and Road Show. E. L. Powers, secretary, 150 Nassau street, New York.

February 7-15 at the Coliseum, Chicago, Ill. The tenth Cement Show. Cement Products Exhibition Co., 210 S. LaSalle street, Chicago, Ill.

February 8-10 at Hotel LaSalle, Chicago, Ill. American Association of Engineers, headquarters, 29 S. LaSalle street, Chicago, Ill.

February 8-10 at Hotel LaSalle, Chicago, Ill. American Concrete Institute. Harold D. Hynds, secretary, 1418 Walnut street, Philadelphia, Pa.

February 12-14 at Chicago, Ill. American Concrete Pipe Association. E. S. Hanson, secretary, 538 S. Clark street, Chicago, Ill.

February 19-24 at Kansas City, Mo. The Southwestern Concrete Association and Exhibit. Saturday is good roads day. Charles A. Stevenson, chairman exhibit committee, 1433 W. Tenth street, Kansas City, Mo.

May 7-11 at Hotel Jefferson, Richmond, Va. American Water Works Association. J. M. Diven, secretary, Troy, N. Y.

May 8-10 at Washington, D. C. National Fire Protection Association. Franklin H. Wentworth, secretary, 87 Milk street, Boston, Mass.

The Northwestern Road Congress

The Northwestern Road Congress held in Chicago December 7 and 8 was an enthusiastic gathering favoring better roads and was supplied with many good addresses by state highway officials and other road experts and good roads enthusiasts. A sentence in the address by H. G. Shively, chief engineer of the Maryland State Highway Commission, is significant. He said that the eastern states are far behind those of the west in the good roads movement because the western states are not using the trunk line system connecting the good roads of one state with those of another.

A. D. Gash, chairman of the Illinois State Highway Commission was elected president for the ensuing year, succeeding John A. Hazlewood, the head of the Wisconsin State Highway Commission.

There were many excellent exhibits in connection with the Congress. Prominent among them were the following:

The Asbestos Protected Metal Co., of Pittsburg, Pa., represented by R. George Miller and their local dealer, G. A. Sellar of the Sellar Supply Co., with the Pittsburg paving joint, a premolded all-asphalt joint material, which has demonstrated its practicability.

The Dunn Wire-Cut-Lug Brick Co., with the most generally used form of brick for paving now in the market.

The Illinois Paving Brick Publicity Bureau, representing the paving brick interests of the state.

The Pioneer Asphalt Co., of Lawrenceville, Ill., with their Pioneer paving cement for asphalt pavements, Pioneer road asphalt for road treatments and for asphaltic concrete, and the Pioneer paving joint compound.

F. J. Lewis Mfg. Co., of Chicago, Ill., with road tars, road building machinery, coal tar paving pitch, road oiler, portable heating tanks, pouring cans and the like.

The United States Asphalt Refining Co., with Aztec asphalt for all paving and road treatment purposes.

The Koehring Machine Co., of Milwaukee, represented by G. E. Hillsman, district manager, Chicago, Ill., with the well-known Koehring mixer which gives "more batches per day."

The Russell Grader Mfg. Co., Minneapolis, Minn., with road scrapers, graders, plows and other road construction machinery.

Add Another Paving Joint

By a typographical error the Pittsburg paving joint, made by the Asbestos Protected Metal Co., of Pittsburg, Pa., was omitted from the list of premolded joint materials used for making expansion joints along curb and across the street in brick and concrete pavements. The list will be found on page 128 of the October number of MUNICIPAL ENGINEERING in the article on the construction of brick pavements.

Personal Notes

E. L. Wells is the city manager at San Angelo, Tex. H. M. Garden is city engineer.

Frank I. Bennett, formerly an alderman, has been appointed

Commissioner of Public Works of Chicago, Ill., to take the place of William R. Moorhouse, who resigned in November.

C. C. Huffine is the city engineer of Frankfort, Ind., taking the place vacated by the death of R. H. Boynton.

Geo. H. Royle, Trenton, N. Y., is head of the construction department of Mercer county roads.

Geo. A. Johnson, consulting engineer, New York, will serve as engineer in the reconstruction and rearrangement of the Bayonne, N. J., water system.

Henry Welles Durham, county engineer of Bergen county, Hackensack, N. J., who has been absent on leave with his regiment, the 7th New York Infantry, at McAllon, Texas, has returned to his office, having come back to New York with his command, which has been mustered out of active duty with the United States Government.

Allen Kisinger is the new city engineer at Norwood, O.

Raymond W. Parlin has been appointed deputy commissioner of the New York street cleaning department.

The U. S. Office of Public Roads and Rural Engineering has appointed the following district engineers: L. I. Hewes, Washington, Oregon and Idaho; C. H. Sweetser, California, Nevada, Arizona and New Mexico; J. A. Whittaker, Montana, Wyoming, Utah and Colorado; E. O. Hathaway, the Dakotas, Minnesota and Wisconsin; J. C. Wonders, Nebraska, Iowa, Kansas and Missouri; J. D. Fauntleroy, Arkansas, Louisiana, Oklahoma and Texas; J. T. Voshell, Michigan, Illinois, Indiana and Kentucky; J. T. Bullen, Florida, Georgia, Alabama, Mississippi, South Carolina and Tennessee; Guy H. Miller, Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont, and H. K. Bishop, Pennsylvania, Ohio, West Virginia, Virginia, Maryland and North Carolina.

Jesse Taylor

Jesse Taylor, perhaps the most prominent advocate of good roads in Ohio and well known over the country as the managing director of the National Highway Association, died at Jamestown, O., December 7.

Mr. Taylor was a banker, who became interested in good roads and started a little periodical to help in the campaign, which developed into the magazine now known as *Better Roads and Streets*, to which he has devoted a large share of his time for several years.

His enthusiasm and push made him a leader in the good roads movement in many lines and carried him into many states, and his name was a household word in Ohio in the good roads movement.

Technical Schools

There will be nine vacancies in the Engineering Experiment Station Research Fellowships of the University of Illinois for the next school year. The appointments to fill these vacancies will be made in the spring of 1917 and applications should be made before February 1. Allowance of $500 is made to each holder of a Fellowship and about half his time is devoted to work in the special department to which he is assigned, the remainder being available for graduate study. Full information can be obtained from the Director of the Engineering Experiment Station, Urbana, Ill.

The sixth annual road school of the Wisconsin Highway Commission will be held at the State Capitol, Madison, Wis., the work of January 29. Registration this year will probably be higher than the 700 of last year.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

January 9: Leading draftsman, ordinance department at large, in the Frankford Arsenal, War Department, Philadelphia, Pa., at $2,400 a year.

January 16: Supervising mining engineer and metallurgist in Bureau of Mines, Department of Interior for service in the field at $4,000 a year.

January 17-18: Aid qualified in chemistry in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., at $600 to $840 a year; assistant examiner, Patent Office at $1,500 a year; mechanical draftsman in Patent Office, Department of Interior, Washington, D. C., at $1,000 a year; surveyor and transitman in the General Land Office, at $100 to $110 for transitman and $125 to $150 a month for U. S. Surveyor.

January 23: Architectural draftsman in Office of Public Buildings and Grounds, Washington, D. C., for 6 months at $130 a month.

Garbage Contract Is Let

F. G. Royster, of Norfolk, Va., was given the contract to handle the by-products of the municipal garbage reduction plant by the board of control Friday. Royster bid $57,000 for 6,000 tons of fertilizer, the highest ever received by the city and some $9,000 higher than last year.

Tenth Cement Show

The tenth annual cement show will be held by the Cement Products Exhibition Co., at the Coliseum, Chicago, February 7-15, 1917.

This year the show will all of it be contained in the Coliseum, which will be quite a convenience for both exhibitors and visitors. This decision makes it necessary to concentrate space to some extent, but the advantages will offset any slight inconveniences suffered on this account.

The number of exhibitors is large, amounting to 161 at the date this is written. They cover all branches of the field, cement, cement workers' tools, cement roofing, cement products machines, publishers of periodicals, dump wagons, reinforcing, meters, steel, molds, artificial stone, steam and gasoline engines, concrete road machinery, protection joints, expansion joints, bags, cement placing machinery, tile machinery, waterproofing, cement vaults, post molds, cement decorations, fillers, elevators and conveyors, motor trucks, concrete mixers, sand, gravel and stone, electrical machinery, sack baler, forms for curbs, gutters, foundations, walls, etc., joint fillers, excavators, buckets, silos, paints, crushers.

Publications Received

The revised general specifications for bridge work of the Illinois State Highway Department for 1917 have been issued and can be obtained by those interested from the department at Springfield, Clifford Older, bridge engineer.

A progress report on the Oxford Pike concrete service test road in Philadelphia has been issued by William H. Connell, Chief of the Bureau of Highways, which is available by those interested on application to him.

The publications of the Committee on Unemployment of the Mayor of New York are obtainable of the Secretary of the Committee, Room 2028 Municipal Building. They include for free distribution the report of the committee of January, 1916, and the new 32-page report on planning public expenditures to compensate for decreased private employment during business depressions; also for sale the new report on dock employment in New York, 50 cents and on how to meet hard times, being a program for the prevention and mitigation of abnormal unemployment, 25 cents.

MACHINERY AND SUPPLIES

The Garbaget

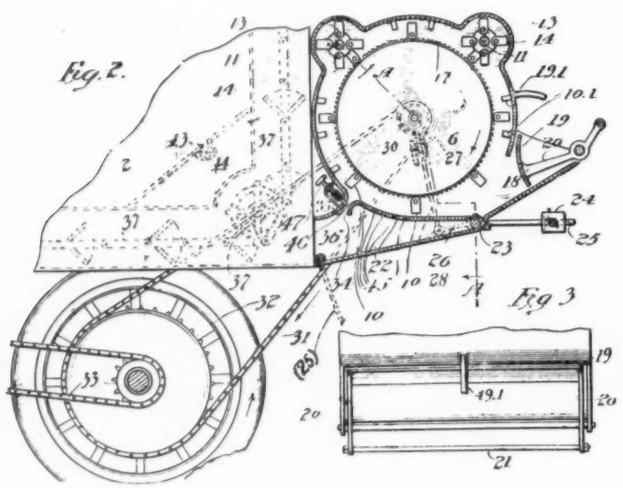
An idea has been developed by Edwards B. Stuart of Chicago into patentable form which, when it is worked out in the form of the necessary machine at work, may revolutionize the disposal of garbage.

In brief, it is a motor-driven machine which travels about the city collecting garbage and changes the collected materials, as rapidly as they are fed into the machine, into a dried and powdered form, which is ready for the extraction of the grease from it and, either with or without that operation, for use as a fertilizer.

The idea is distinctive, the only approach to it a portable garbage and refuse destructor, tried unsuccessfully a few years ago, which did not attempt to utilize the valuable constituents of the garbage. The principal object of the garbaget is to make this utilization possible, next, of course, to disposing of the garbage with the least possible danger of nuisance. A distinctive idea demands a distinctive name and the inventor has devised "garbaget," an evolution from the garbage-eating propensities of the machine.

The accompanying drawing gives some idea of the construction and method of operation of the machine. The garbage is dumped into the trough or chute at the rear of the machine at 18, which opens by the weight of the garbage can on a bar connecting the arms operating the closing plate. When the can is emptied and removed the opening is closed automatically. Once the garbage is inside it is rendered entirely innocuous in every respect before it emerges from the apparatus.

In the small compartment at the rear is mounted a cylinder, on the outside of which are mounted swinging hammers which strike on teeth projecting from the inner surface of the encasing cylinder, so that the garbage introduced as above described is pounded by a flail-like motion and thoroly comminuted. Two smaller shafts in the upper corners of the casings, at 11, mounted with hammers operating between those mounted on the larger cylinder, aid in the reducing process and in thoroly mixing the mass. The lever 25 serves to throw the garbage comminuting apparatus in gear with the driving chain run by the sprocket on the rear wheel of the motor truck. A perforated plate with one end movable separates the chamber of comminution from a chute leading to the large storage chamber forming the larger part of the apparatus. The finely divided garbage passes thru the perforations in this plate and a small opening along one edge, or can be dumped by moving the free end, either into the storage chute or to the ground or a small vehicle or box beneath.



From the chute the fine garbage is carried by a bucket conveyor up and across the top of the storage chamber, where trap doors permit its deposit in the storage chamber. In the rear of this elevator shaft is a door above the crusher chamber, thru which the material not to be crushed can be dumped into the conveyor for deposit in the storage chamber.

In the bottom of the storage chamber is a device for discharging the hot gases from the motor of the truck into the material in the chamber, so that it is dried by the heat thus applied. Drainage devices are provided for collecting the oil condensing on the walls of the chamber from the hot gases after they pass thru the garbage.

The oxidation of the garbage, resulting during the process of pulverizing it, is reported to remove all objectionable odors, so that the machine can operate on the city streets and alleys without appreciable nuisance.

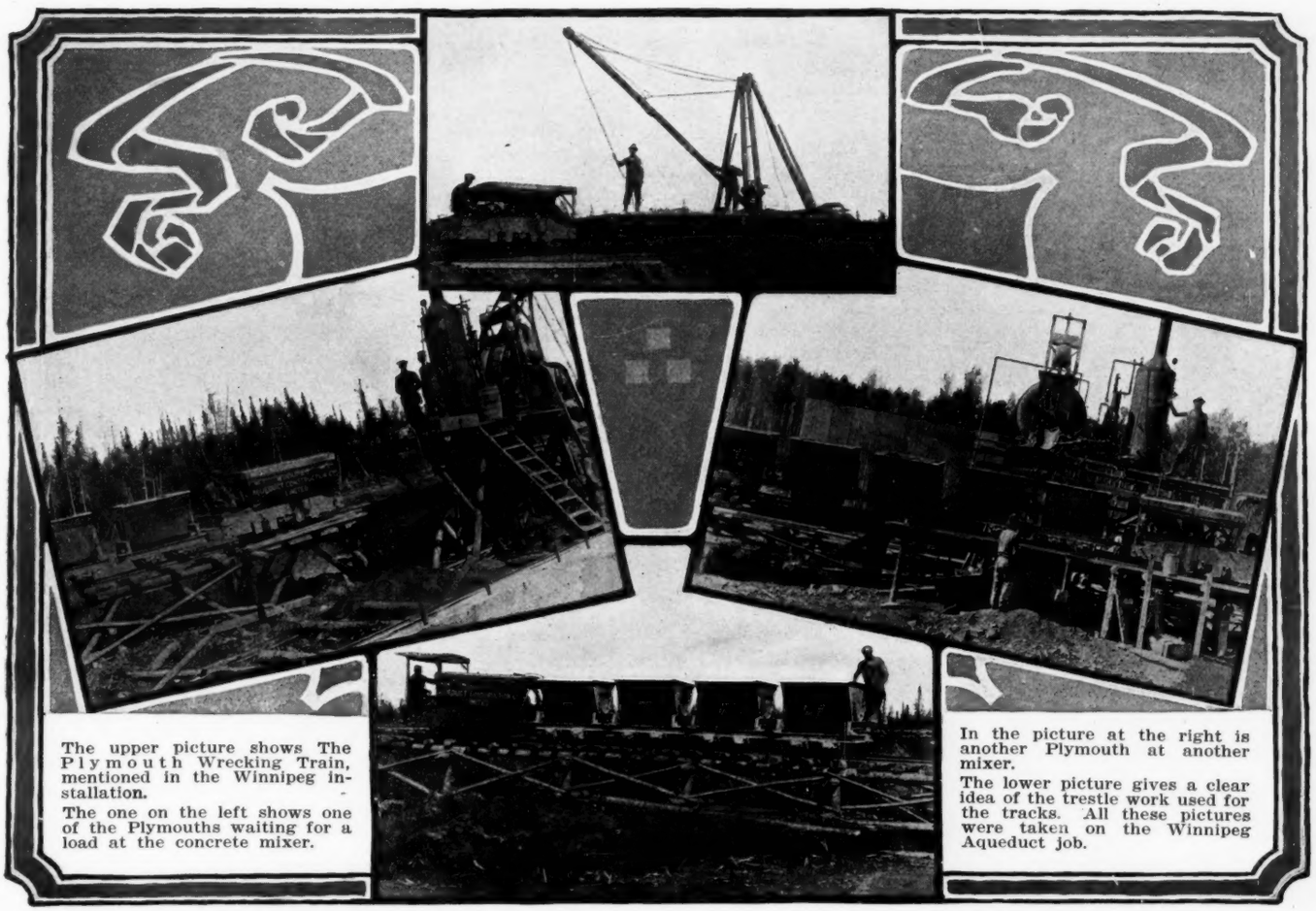
Any material which cannot be broken up in the crusher is forced against the movable side of the division plate above referred to, and the motion throws the crushing apparatus out of gear, thus preventing damage to it.

The removal of moisture from the garbage by the heat reduces volume, and especially weight, and increases the carrying capacity of the machine as compared with one collecting raw garbage.

Gasoline Locomotives in Contract Work

It is a notable fact that contractors handling big construction work are coming more and more surely to the regular use of gasoline locomotives whenever haulage between two fixed points is a problem. Extremely low working cost, speed and dependability are three of the great determining factors in their decision.

Time was when the use of small locomotives of this sort was largely confined to industrial service and mining transportation, but current and thoro investigation shows them now in



The upper picture shows The Plymouth Wrecking Train, mentioned in the Winnipeg installation.

The one on the left shows one of the Plymouths waiting for a load at the concrete mixer.

In the picture at the right is another Plymouth at another mixer.

The lower picture gives a clear idea of the trestle work used for the tracks. All these pictures were taken on the Winnipeg Aqueduct job.

general use in road building, in gravel pits and brickyards, as well as on construction work.

Typical Gasoline Locomotive.

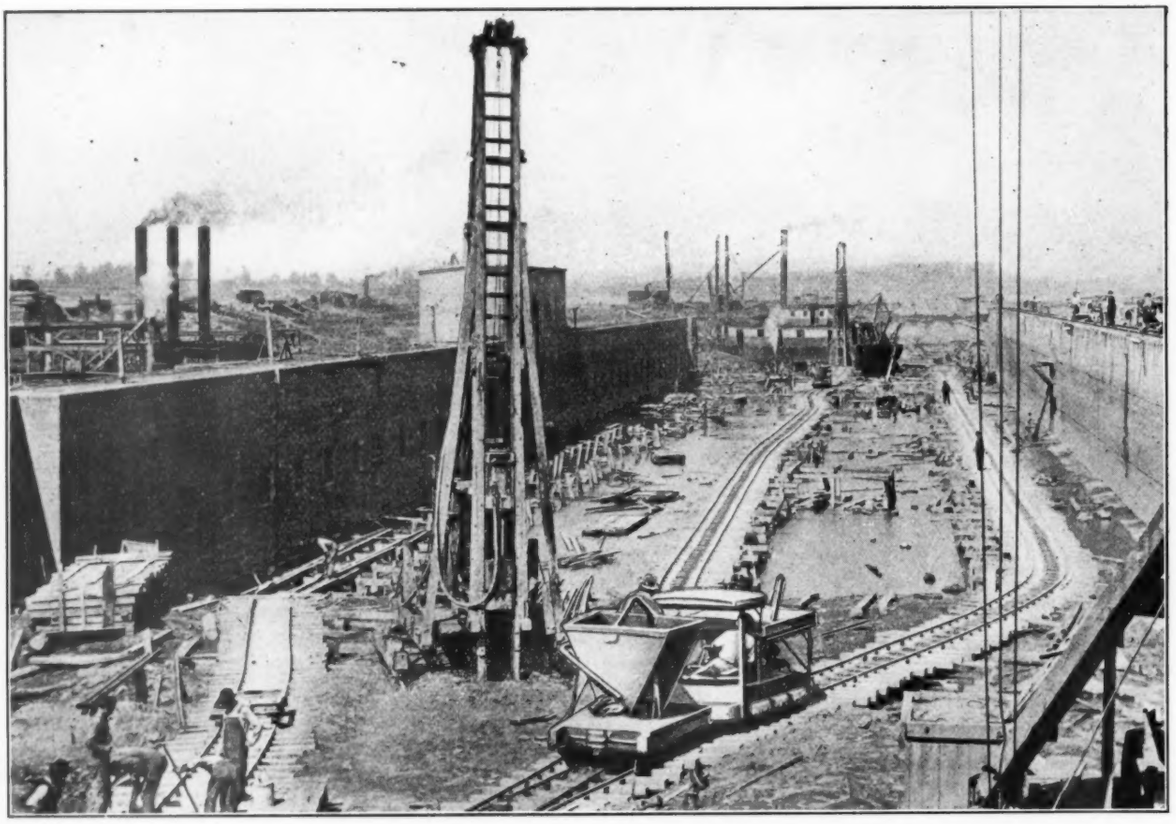
A typical engine of this type has as one of its main features a friction drive for variable speed-transmission. A 4-cylinder vertical engine at the right of the tank drives a face wheel or friction disk at the left. Against the face of this disk runs the rim of the wheel on the transverse shaft, this wheel being fitted with a fiber ring. Speed is varied by merely shifting this wheel laterally along its shaft so as to ride against the higher or lower speed portions of the disk. A sprocket chain from this shaft drives a countershaft with chain drives to both axles.

The frame comprises four heavy castings which impart weight and stability. Pockets in the end castings provide for convenient coupling to cars of different heights. In the 3-ton locomotive there is a 23-h. p. engine (at 1,000 r. p. m.) driving a 23-inch friction disk and 22-inch fiber-faced wheel. It is mounted on four 18-inch steel wheels, with a 30-inch wheelbase. All bearings are fitted with flexible roller bearings, except that double-row ball bearings are used for the shaft of the friction disk.

Speed and Pulling Statistics.

The machine has a maximum speed of approximately 10 miles per hour, and a drawbar pull of 1,200 pounds at 5 miles per hour. It carries 20 gallons of gasoline and 50 gallons of

THESE SIX PLYMOUTHS WERE IN THE FIRST SHIPMENT SENT THE WINNIPEG AQUEDUCT CONSTRUCTION CO., LTD., IN 1915. BEFORE THE CLOSE OF THAT SEASON THREE ADDITIONAL PLYMOUTHS HAD BEEN SENT THIS SAME CONCERN.



DAM NO. 48 IN OHIO RIVER SHOWING THE PLYMOUTH LOCOMOTIVES AT WORK ON GREAT PROJECT.

water and consumes from 5 to 6 gallons of gasoline in the course of a 10-hour working day.

The 6-ton machine has a 50-h.p. engine, giving the same maximum speed, but a drawbar pull of 2,400 pounds at 5 miles per hour.

The locomotives are built for tracks of 24 to 56½-inch gage and with or without a cab, according to the character of the service which they are expected to perform. In service the mechanism is protected by curtains.

Among the larger and more recent construction jobs upon which these engines have been used are the Louisville & Portland canal lock at Louisville, Kentucky; the Ohio River dam No. 48; New York State highway work; the Boston dry-dock and the Halifax harbor works.

The Winnipeg Aqueduct Job.

There are no less than nine such gasoline locomotives (all of the Plymouth type) now helping the Winnipeg Aqueduct Construction Company, Ltd., of Winnipeg, Manitoba, Canada, do its share in building the $13,500,000 project now under construction in the Lake of the Woods regions. This project is an aqueduct nearly 100 miles in length, and is intended to furnish Winnipeg with a daily supply of 100,000,000 gallons of water.

The work involves the building of a construction railroad 102.4 miles long, a diversion dyke and channel, 85 miles of concrete aqueduct, a 250,000,000-gallon reservoir and 2.3 miles of 4-foot cast iron pipe. Of the $13,500,000 contract, the Winnipeg Aqueduct Construction Company has nearly $4,000,000 of the award, and, as previously stated, the nine Plymouth locomotives are busy as little bees hauling material from one point to another, dumping concrete from the mixers to the forms and generally making themselves useful.

Bad Tracking Conditions Overcome.

The work where the gasoline engines are doing daily duty lies almost entirely in muskeg. This is a peat bog, saturated with water, covered with moss, with roots and decayed wood below and various underlying soils. Ofttimes the "Plymouths" are up to their hubs in the mire and the workmen on the job have declared that no other type of outfit could stand the extraordinarily heavy work imposed upon the dimunitive locomotives.

Details of the Concrete Haul.

In the concrete work the ground is so soft that the contractors have been forced to place stationary mixers at suitable points. From the mixer an elevated log trestle curves both ways to met a track laid on the top of the dump along the south side of the excavation. A short track also runs the entire length of the gravel platform. The Plymouth trains—composed of three to four steel hopper cars holding ¾ cubic yard of concrete—take the concrete from the mixers, run along about half a mile of level track on either side of the mixers to the dump, making the trips in an unusually short time, with the season's average consumption of ½ gallon (Imperial) gasoline per hour.

J. B. McLean's Testimony.

Commenting on this long haul for concrete to the dumping point, Mr. J. B. McLean, manager of the Winnipeg Aqueduct Construction Company, states: "The concrete has been successfully handled in this manner for a distance of ½ mile on either side of our mixing plant. No difficulties have appeared in this long transportation, there being no segregation of the materials and no difficulty in dumping the concrete, even at the extreme ends of the work.

"At the beginning of last season we ordered six of these locomotives. In September we found that we could use another one, and, as we are opening two additional camps this season, we have ordered two more from the J. D. Fate Company, of

Plymouth, Ohio. This will make nine of these locomotives which we have on one job up to date.

"We can speak very highly of the satisfaction which these machines have given us. They are able to pick up their loads quickly, get away without fuss or bother under full power and speed, and also return to the mixer in record-breaking time that makes our long hauls of concrete possible. They have cost us very little for repairs, and, for the amount of power they generate, they are not expensive as to gasoline consumption. They have literally done everything the makers promised they would do."

Hauling Gravel and Handling Wreckage.

Another duty imposed upon the little locomotives on the Winnipeg aqueduct job is the hauling of gravel to the concrete mixers. This material is brought from near-by pits to the mixers and the engines manage to keep these busy.

One of the unusual features of the work they are doing there, however, is the handling of a wrecking train. With such unstable tracks the small dump cars and even the larger and heavier regulation freight gondolas topple over into the mire. A wrecking crane is rigged up on a flat-car and the Plymouth is "First aid to the Injured" quite frequently during the course of the day. One of the accompanying illustrations shows the Plymouth wrecking train and crew, and gives some idea of the log trestle track over which it and its eight companion engines are forced to travel.

How Ohio River Contract Company Broke World's Concreting Record.

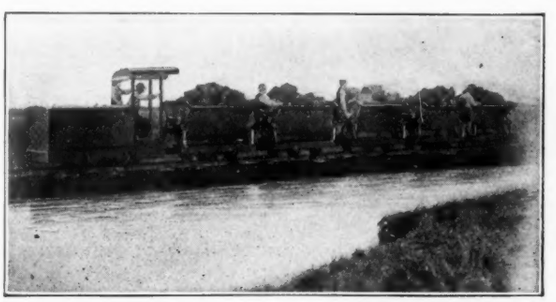
Two other little gasoline locomotives of the same type recently enabled the Ohio River Contract Company to break a world's record in concreting, and, at the same time, brought about a condition that was unusual in construction work in the building of Dam No. 48 across the Ohio river, just below Evansville, Indiana.

The unusual condition to which reference is made is that the contractor was forced to *decrease* his speed in order to comply with the contract and specifications, whereas customarily exactly the opposite prevails, the contractor being more often compelled to pay forfeit for not completing the job within the stipulated time limits.

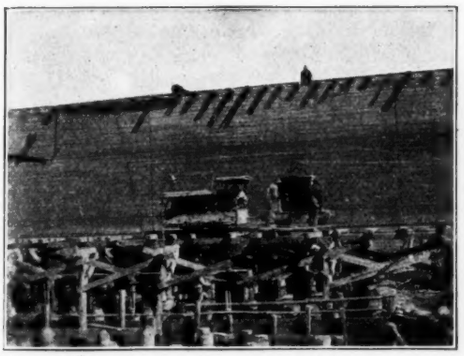
This dam is being built under United States government supervision and is the longest movable dam in the world, as well as the only one constructed upon a shifting sand foundation.

Saves Them $44.00 Every Eight Hours.

The Ohio River Contract Company states that it has replaced six mules with each gasoline locomotive, with a driver to each mule, two locomotives and two drivers now doing far more work in less time than the twelve mules and twelve drivers formerly accomplished, and, coincidentally effecting an actual saving (by a daily record of costs) of $44.00 in haulage cost every 8 hours. Furthermore these locomotives are run both day and night, thus doubling the working hours of the mules, which must, naturally, have some rest out of the twenty-four hours.



THE PLYMOUTH TAKING A TRAIN OVER THE BOG AND MIRE OF LONG BEACH.



NOTE LOCOMOTIVES RUNNING ALONG TRESTLE—OHIO RIVER DAM 48 JOB.

What L. P. Eichel Says.

Leslie P. Eichel, purchasing agent for the Ohio River Contract Company, states in a recent letter: "This has been a very wet season, and we have had to place concrete at short intervals, at great speed, to keep ahead of the 'rises.' In placing the concrete into the floor of the lock, the two Plymouth locomotives had to operate a maximum round-trip distance of 1,600 feet, with a stop for loading concrete at the mixer and a stop for dumping the material, the average time of which was, for each locomotive, less than 4 minutes, day and night, for 22 days. This time included all breakdowns to concreting machinery and other delays caused by similar mishaps.

"Each train pulled 1¼ yards of concrete over a trestle-way for a distance (round trip) of 600 feet, including both stops, and for several hours one locomotive made the journey in one minute. However, as the United States government permits only 45 cubic yards an hour we were not permitted to maintain this speed any consecutive number of hours. It was one of the first cases on record where the contracting officer had to cut down the speed under which a contractor was working.

"We placed with these two Plymouth locomotives—using one only half the time and two the remaining half—9,810 cubic yards of concrete in 269 hours, including all breakdowns to concrete machinery and other delays. This is a rate of 36.5 batches per hour. In one 12-hour shift, or rather in one 12-hour run, as shifts have to be changed every 8 hours, on the 1,600-foot run we placed 513 cubic yards with the two locomotives, including all breakdowns to concrete machinery and other delays. (We never deduct for breakdowns and delay.)

"On a shorter run, with one locomotive, we placed 475 cubic yards in 12 hours; on the long run (1,600 feet), 355 cubic yards in 8 hours with two locomotives.

"We could go on indefinitely. Unfortunately our working season, so far, has been very short. Otherwise we would have had other record-breaking figures to present you.

"The saving to us, per locomotive, per 8-hour shift, is estimated by our office to be $22. One locomotive takes the place of six mules on a day and night run.

"At Louisville we are testing out a Plymouth in comparison with a number of steam dinkies. We are certain the little locomotive will win out."

Pertinent Cost Figures.

The following data were given out by Mr. Eichel from his daily itemized cost record:

Labor cost per hour, Plymouth Locomotives...$0.37½
Labor cost per hour, horse-driven power 1.40
Difference in cost per hour for labor, in favor of Plymouth Locomotive 1.02½

Cost per ton mi. hauling with Plymouth, 200 ft.	.1339
Cost per ton mi. hauling with Plymouth, 300 ft.	.1041
Cost per ton mi. hauling with Plymouth, 400 ft.	.0950
Cost per ton mi. hauling with Plymouth, 500 ft.	.0870
Cost per ton mi. hauling with Plymouth 600 ft.	.0819
Cost per ton mi. hauling with Plymouth, 700 ft.	.0783
Cost per ton mi. hauling with Plymouth, 800 ft.	.0761
Fuel cost, per hour, gasoline.....	.1100
Lubricating oil cost, per hour.....	.0400

"We consider these small engines," he says further, "much cheaper to operate than any other system on account of less labor in operating, increase in work done per hour and plant erection to permit operation. In comparison with horse-driven power the locomotive is undoubtedly much cheaper. We are particularly favorably impressed with the friction drive on our Plymouth engines and fully believe that the expense of replacing the fiber rim on same is less than the cost of transmission lubricants for most gear-driven locomotives.

U. S. Government Engineer Says.

E. H. Wise, junior engineer of the War Department, United States Engineers' office, under whose direction the Government dam work on the Ohio River Contract Company's job was done, supplements the contractor's statement as follows:

"Between August 6 and October 3 (269 hours) a total of 9,136 yards of concrete was placed in the lock floor at an average rate of 36.5 batches per hour. All of this was handled by two Plymouth gasoline locomotives, the major portion by Locomotive G-1, which handled 7,472 batches and traveled 1,434 miles, and the remainder by Locomotive G-2, which handled 2,338 batches and traveled 233 miles. The maximum haul was 790 feet, and the minimum haul 215 feet.

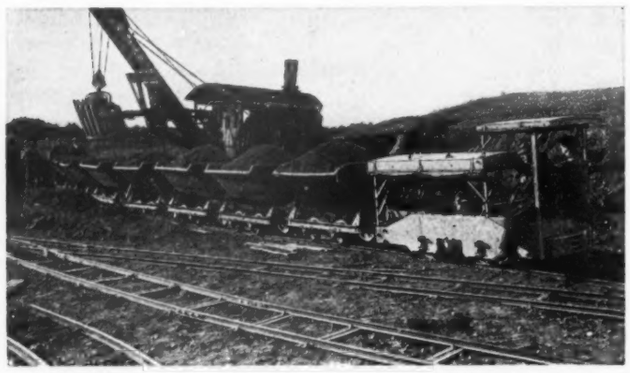
"Each locomotive pulled a single truck carrying 1-yard bottom-dump concrete bucket. There was a slight down-grade in the track for about 150 feet adjacent to the mixer, the remainder being level."

New York State Highway Contract.

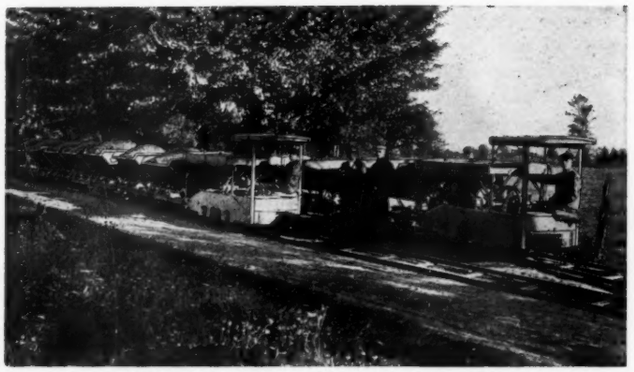
The adaptability of the gasoline locomotive to different requirements in road building is shown by the experience of Phelan and Sullivan, general contractors of Utica and Syracuse, New York. This concern hauled gravel 2¼ miles—which is a pretty fair haul—and accomplished it at a cost of only 5 cents per cubic yard, far below what a contractor, who is depending on horse and wagons, could expect to do the same work for.

Phelan and Sullivan's two locomotives were first employed on state highway work in New York state where they had the contract to build the Syracuse-Bridgeport road. Inasmuch as they had secured the contract at a pretty close figure it was essential that they find some means of reducing normal costs.

Every item was gone over and it finally was decided that



PLYMOUTH TRAIN TAKING ON LOAD AT GRAVEL PIT.



TWO PLYMOUTH TRAINS MEETING ON TRIPS TO AND FROM GRAVEL PIT.

in hauling lay the best point of attack. After an investigation it was decided to supplant teams with some form of power. Various power-driven machines were given consideration, the gasoline locomotive finally being selected to solve the problem. With what success this was accomplished is best told in the words of Mr. L. D. Sullivan, of Phelan and Sullivan, himself. He says:

"Both of the little locomotives have given perfect satisfaction and really are doing more than was guaranteed for them. We are hauling gravel on a 24-inch gage railway and, at present, are hauling a distance of 2¼ miles. The machines make ten trips each per day with nine 1½-yard cars, making a total of 270 cubic yards of gravel per day.

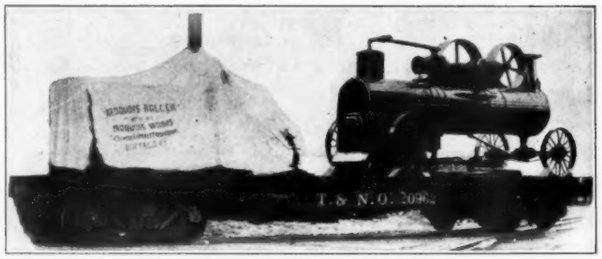
"The cost of operation is $13.50, which includes two runners at $2.50 each, and two brakemen at $2.00 each; 20 gallons of gasoline and 1 gallon of oil, all of which makes the total cost of the haul (approximately 2¼ miles) 5 cents per cubic yard.

"We have two slight grades of approximately 1 per cent on this haul, and we have hauled twelve loaded cars up these inclines without putting the locomotives under any apparent strain. On other work the engines serve steam shovels, handling cars of excavated material."

Paving Equipment for Cuba

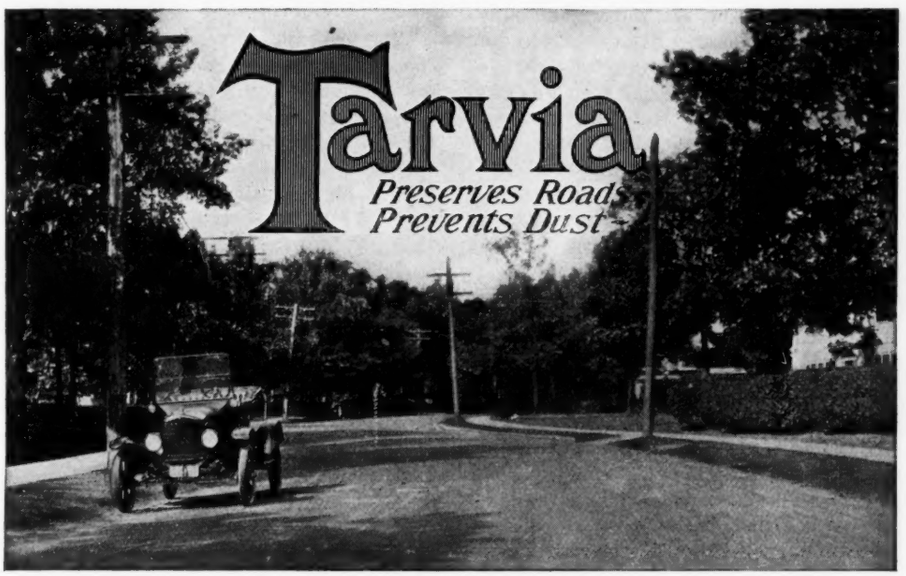
One of the largest single shipments of paving equipment on record is that just made to Messrs. Torrance & Portal, of Havana, Cuba, who have secured extensive paving contracts in Havana and Cienfuegos.

The shipment made by the Iroquois Works of The Barber Asphalt Paving Company consisted of six cars routed by way



of Key West, Florida, carrying two 3-unit asphalt plants, two 2,000-gallon and one 1,000-gallon steam heated melting kettles, 4 tandem rollers, 2 portable boilers and engines, fire wagons, paving tools, etc.

Contracts already secured by the Havana firm for paving in which Trinidad lake asphalt will be used, total about 400,000 square yards. One of the Iroquois plants is to be located at Havana and the other at Cienfuegos.



Everett Avenue, Winchester, Mass.
Constructed with "Tarvia-X" in 1915.
Treated with "Tarvia-B" in 1916.

Tarvia vs. Oil

LIKE many towns, Winchester, Mass., tried both oil and Tarvia to preserve its roads and prevent dust. In 1915 the Superintendent of Streets reported to the Selectmen as follows:

"I recommend a change in the methods of oiling. I would eliminate contract oiling because of its bad results, and I would increase the tar treatment (Tarvia) because of its durability, cleanliness and smaller unit cost of upkeep. I would not use so-called asphaltic oils on any streets except Forest Street and Highland Avenue. The non-asphaltic oils require no sand and do not make mud if they are sprayed on clean surfaces. It is expensive to apply one coat of oil and sand and then remove several layers of oily mud after each rain."

In their annual report the Selectmen quoted the above, and then said:

"We believe the result has justified his recommendations and that the streets are better preserved and in the course of time will cost far less for repairs and be more nearly dustless by this method (Tarvia) than if oil were used. The condition of our Square this winter as compared with previous years, when oil was used, is good proof of this. After rains, the road bed dries quickly and is never covered with an oily mud."

The Tarvia referred to in the Winchester report was "Tarvia-B." The road was cleaned, the "Tarvia-B" was applied cold from a pressure distributor, and spread evenly over the surface. In a few hours it soaked well into the macadam, forming a tough, slightly plastic binder. The carpet of Tarvia-bonded stone thus formed was durable, waterproof and dustless. The expense was trifling—the results most satisfactory. This method is the cheapest as well as the best way of maintaining macadam.

There are three kinds of Tarvia and a dozen ways of using it.

Booklet describing the various treatments on request. Address our nearest office.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems.

The advice of these men may be had for the asking by anyone interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

The Barrett Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh
Detroit Birmingham Kansas City Minneapolis Nashville Salt Lake City Seattle Peoria
THE PATERSON MANUFACTURING COMPANY, Limited: Montreal Toronto Winnipeg
Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

TRADE B MARK

Dynamite in Road Improvement

By J. B. Stoneking, M. E.

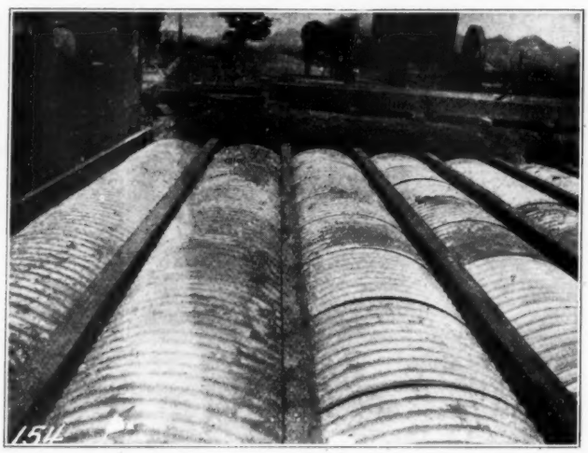
There is such a heavy increase of traffic on all roads in this country, more especially on the main trunk highways between cities and towns of importance and the roads leading from the more populous country districts into the markets, that a very necessary and radical change has been forced in road building and improvement methods. Not many years ago, plain gravelled and water-bound macadamized roads stood the wear and tear of the then comparatively light and slow-moving vehicles. Light surfacing was the rule and materials which would stand up under that traffic were found to be inadequate when subjected to the abrasion and hard pounding of our heavier and rapid-moving vehicles of the present day.

Since the development and perfecting of the auto truck for hauling and delivery purposes, the slow wide-tired wagon has been largely replaced. This type of traffic has spelled the doom of earth roads, and tears holes in lighter, more easily worn surfacing with amazing ease and rapidity. It has also caused a cry to be raised for easier grades. The lighter pleasure automobile is almost as hard on road surface as the truck, and the higher speed has increased the number of bad accidents on sharp curves and steep grades. These causes have not only made a heavy, wear-resisting road surface necessary, but in the rebuilding and improvement now being done the roads are widened, grades reduced, sharp turns and dangerous curves eliminated.

The vast amount of work to be done, coupled with the high cost and shortage of labor, has led to the development of successful labor-saving road machinery of many different and highly specialized types. One of the labor-savers adopted from quarry, railroad, and mining work and applied with success to road building is the low-freezing, slow-acting, heaving, low-grade dynamite for earth work in deepening and widening cuts, widening curves around hill sides and points, blasting out stumps, boulders, and trees, and in making side and outfall ditches for drainage. Considerable saving is accomplished by its use in loosening material in conjunction with steam shovels, graders, scrapers, and other machinery.

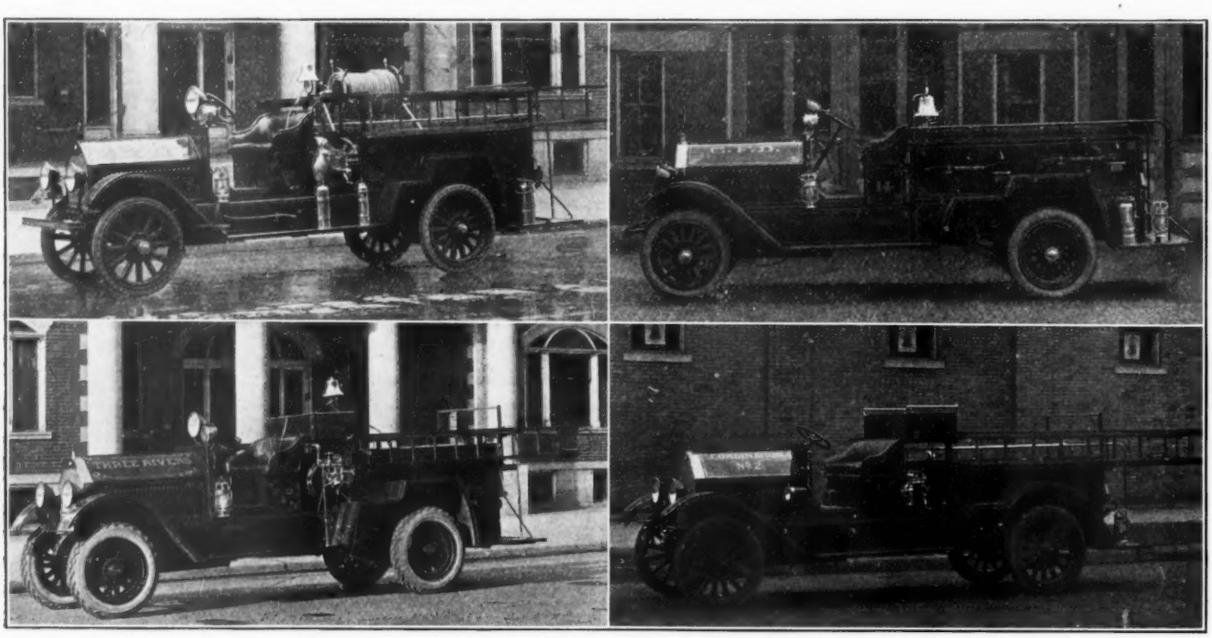
Corrugated Iron in Bridge Flooring

The accompanying photograph shows the placing of part circle pure iron corrugated for use in concrete bridge flooring. On this layer of the corrugated iron will be placed concrete which will be filled above the I-beams to form a wearing surface for the bridge floor. The pure iron used is particularly adaptable to this purpose because it can be formed exactly to suit the conditions and, tho somewhat exposed, being in



contact with the air below, the purity of the iron and the galvanizing insure an indefinitely long life for the metal.

The bridge is one built under the supervision of County Surveyor L. M. Bunce, of Butler County, California, in Supervisor J. C. Albertson's district. The arches shown are of 14-gage American ingot iron, 22 inches span and 4¼ inches rise.



SOUTH BEND "DOUBLE DUTY" FIRE APPARATUS.

TYPE C H 60-4 "DOUBLE DUTY" COMBINATION AS OPERATED BY CITY OF GREENFIELD, IND.

TYPE H 90-6 "DOUBLE DUTY" HOSE WAGON AS OPERATED BY CITY OF CLEVELAND.

TYPE C H 90-6 "DOUBLE DUTY" COMBINATION AS OPERATED BY CITY OF THREE RIVERS, MICH.

TYPE C H 95-4 "DOUBLE DUTY" COMBINATION AS OPERATED BY CITY OF MANITOWOC, WIS.